OCTOBER, 1961
Vol. 15, No. 10

FT food technology

Rough Handling Machine
Revolving 14-ft. Drum

See Page 7
Containers for
Refrigerated Warehouses

JOURNAL OF THE INSTITUTE OF FOOD TECHNOLOGISTS

AN INSIDE LOOK AT FLAVORS THAT SELL

Look closely at any successful flavored product—nutritional supplements for weight control, cereals, beverages or one of many foods consumed daily. Taste it . . . compare it. Why is it some flavors have compelling consumer appeal?

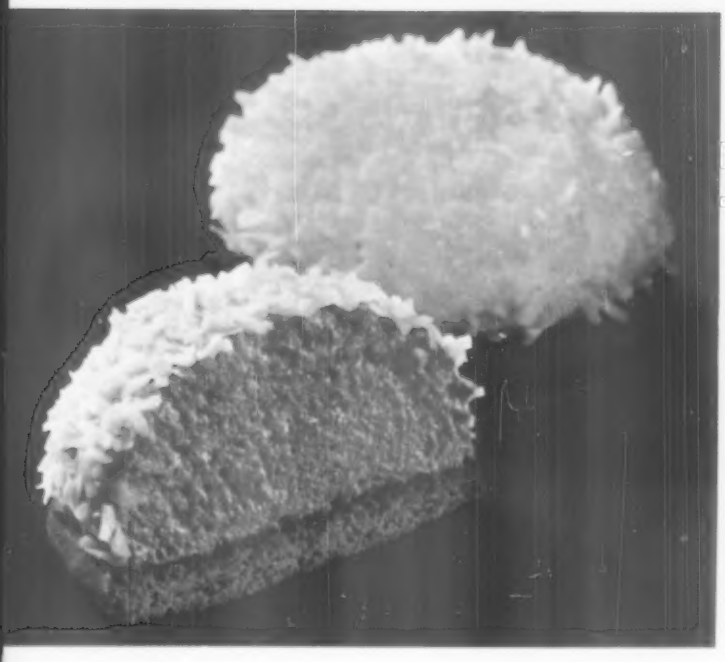
IFF flavors sell and resell for two important reasons. They are exclusively designed for your product, your markets—and they are the finest flavors available. *IFF* flavors have created new product lines, improved established ones and stimulated brand-building sales the world over.

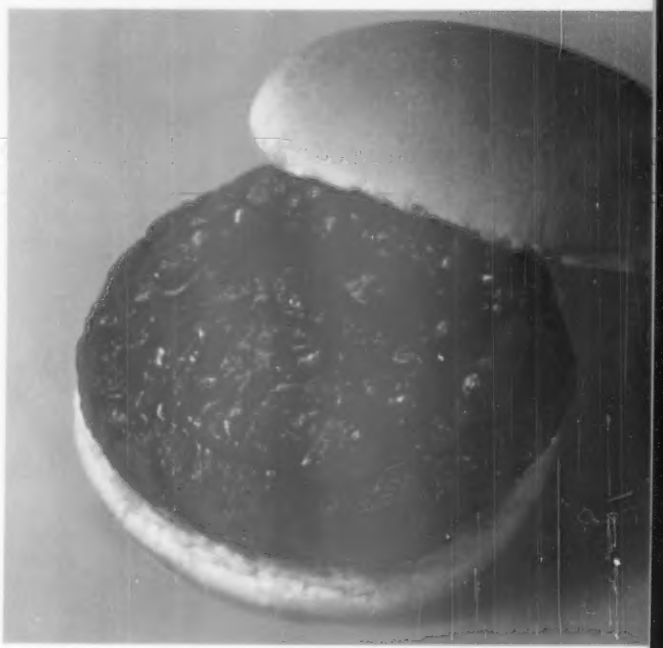
To manufacturers interested in selling abroad, *IFF* can supply your flavor—uniform in taste—from any of its plants throughout the Free World.

For an inside look at flavors designed to sell your products, contact *IFF*.

iff

FLAVOR DIVISION
INTERNATIONAL FLAVORS & FRAGRANCES INC.
417 Rosehill Place, Elizabeth 2, N. J.
Leading Creators and Manufacturers in the World of Flavor
ARGENTINA AUSTRIA BELGIUM BRAZIL CANADA ENGLAND FRANCE GERMANY HOLLAND ITALY MEXICO NORWAY SOUTH AFRICA SWEDEN SWITZERLAND U.S.A.





Flavorful, quality, eye-appealing foods...

naturally superior...when made with

sugars, starches and syrups from...

INDUSTRIAL DIVISION

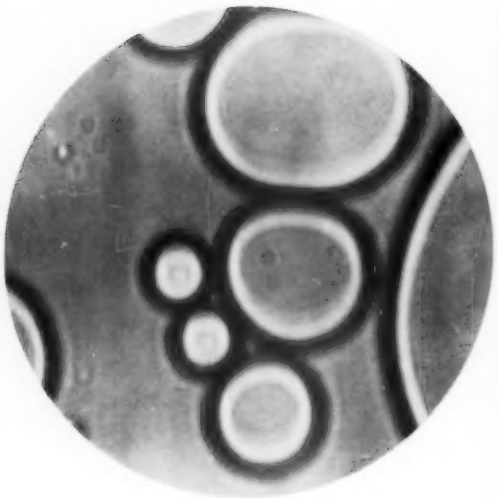
CORN PRODUCTS

COMPANY

WRITE OR PHONE *Corn Products for expert technical assistance... helpful data on these fine products for the Food Industry:*

CERELOSE® dextrose sugar • REX® • GLOBE® • MOR-SWEET® corn syrups • BUFFALO® • HUDSON RIVER® • SNOWFLAKE® starches.

CORN PRODUCTS COMPANY INDUSTRIAL DIVISION • 10 East 56 Street, New York 22, N. Y.



BEFORE: Particle size is coarse, irregular and unevenly mixed with other methods of emulsifying.

AFTER: Particles are broken down to ultimate fineness, are regular and evenly mixed.

Magnification 450X

How Gaulin Homogenizers Make Finer Emulsions At Lower Cost

The secret of finer emulsions lies in the *high pressures* (maximum energy levels) of Gaulin Homogenization.

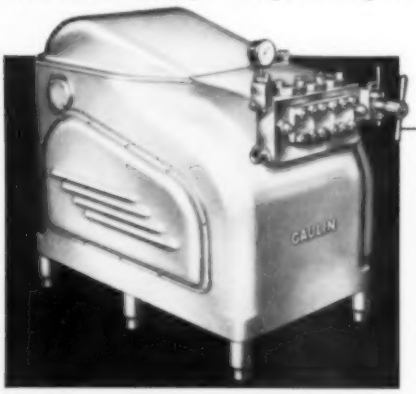
From waxes to pigments, pharmaceuticals to fat emulsions, a Gaulin Homogenizer smashes particles *uniformly finer*, disperses them *more thoroughly*.

Result? You get closer particle control of your product at a considerably lower processing cost.

And just as important, a Gaulin will improve practically every physical and chemical property of your product.

Discover just what a Gaulin can do for your product. Write for more details today.

See Chemical Engineering Catalog for address of your nearby Manton-Gaulin Representative.



Gaulin TRADE MARK

MANTON

Gaulin

MANUFACTURING CO., INC.

82 Garden St., Everett 49, Mass.

World's largest manufacturer of stainless steel reciprocating, rotary, pressure exchange pumps, dispersers, homogenizers and colloid mills.

GTA. *Gaulin Technical Assistance starts with the GTA Library of Product Information. Ask for special bulletins. Then call on Manton-Gaulin for our specialized Technical Assistance. There's no obligation.*

MG 1-1

Executive Editor
GEORGE F. STEWART

Editor Emeritus
C. OLIN BALL

Assistant Editor
KELVIN DEMING

International Editor
GEORG BORGSTROM

Board of Editors
C. P. BOLTON
BEN F. BUCHANAN
RICHARD H. FORSYTHE
J. M. JACKSON
REID T. MILNER
A. I. MORGAN, JR.
JAMES W. PENCE
W. M. URBAIN
MAYNARD A. JOSLYN

Business Manager
CALVERT L. WILLEY

Advertising Manager
R. C. SLUNDER

Eastern Advertising Representative
D. K. MACPHERSON

Publication Office
THE GARRARD PRESS

Mailing Instructions:

Editorial Office: P. O. Box 164, Davis, California. ONLY TECHNICAL MANUSCRIPTS and associated material. A pamphlet, "Research Papers for IFT Journals," is available upon request and was last printed in the January, 1961 issue of FOOD TECHNOLOGY.

Business/Advertising Office: 176 W. Adams Street, Chicago 3, Illinois. All other correspondence, news releases, member subscriptions, changes of address (must be received at least two weeks before date of issue), and claims for copies lost in the mails (must be received thirty days after issue, U.S.; ninety days after issue, foreign).

Eastern Advertising Office: 1465 Golf St., Scotch Plains, N. J.

Publication Office: 510 N. Hickory St., Champaign, Illinois. All requests for non-member subscriptions, back volumes, single copies, reprints, etc. Requests for a single reprint should be addressed to the author.

FOOD TECHNOLOGY is published by the Institute of Food Technologists and printed by The Garrard Press.

Copyright, 1961, by the Institute of Food Technologists.

Mailing Permit: Entered as second class matter, Feb. 25, 1947, at the Post Office at Champaign, Illinois under the Act of August 24, 1912.

Subscription Rates. Domestic, U. S. Territories, Canada and Mexico $11.00; Central and South America $12.00 plus $1.00 postage; all other countries $12.00 plus $2.00 postage. Single copies, Domestic $1.50 each; Foreign $1.75 each, both prepaid. Subscriptions are entered on a calendar year basis only. In the event a subscriber cancels, no refund will be made.

Responsibility for statements, points of view, and mention of commercial products rests solely with the author, and is not an endorsement by the Institute of Food Technologists.

food technology

OCTOBER, 1961
Vol. 15, No. 10

features

First Undergraduate Scholarships Awarded 5
Containers for Refrigerated Warehouses 7
Call for Nominations 12
First Call for Papers 21
1962 Food Technology Industrial Achievement Award Winner to be Named Soon. 30

research

Relation of Gamma-Ray Emission to the Lean Content of Beef Rounds 411
R. KULWICH, L. FEINSTEIN, C. GOLUMBIC, W. R. SEYMOUR, W. R. KAUFFMAN, AND R. L. HINER

The Maturometer—Instrumental Test and Redesign 415
R. S. MITCHELL, D. J. CASIMIR, AND L. J. LYNCH

Deposit of Fresh Frozen Foods. I.
Defrost Temperature of Frozen Fruit Pies, Frozen Meat Pies, and Frozen Soups 419
M. J. FANELLI AND M. F. GUNDERSON

Some Observations on the Continuous Process of Breadmaking 423
R. A. BOTTOMLEY

Survival of Bacteria of Public Health Significance in Frozen Sea Foods 429
H. RAJ AND J. LISTON

Changes in pH of Some Frozen Foods During Storage 434
L. VAN DEN BERG

Maple Sirup. XX.
Conversion of "Buddy" Maple Sap into Normal Maple Sirup 438
A. E. WASSERMAN AND C. O. WILLITS

Changes in Some Volatile Constituents of the Banana During Ripening, Storage, and Processing 440
H. O. HULTIN AND B. E. PROCTOR

Lipid Oxidation in Heat-Sterilized Beef 445
MARELYNN W. ZIPSER AND BETTY M. WATTS

A Method of Analysis of Nonvolatile Encapsulated Substances 448
ROBERT T. MALEENY

Effect of Processing on Distribution and In Vitro Availability of Niacin of Corn (Zea Mays) 450
RICARDO BRESSANI, ROBERTO GOMEZ-BRENES, AND NEVIN S. SCRIMSHAW

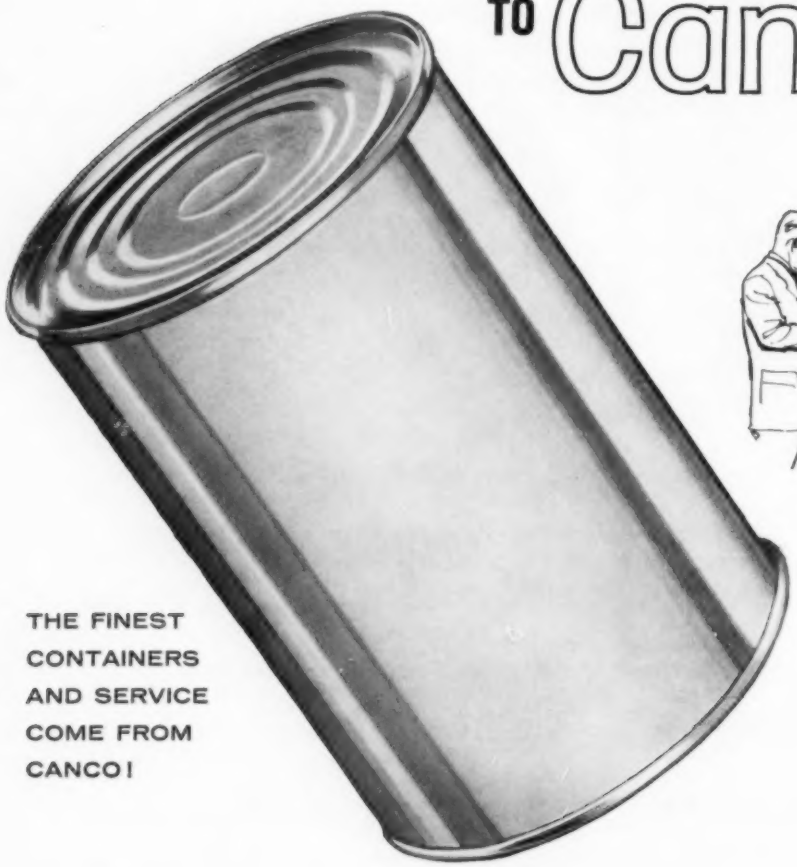
departments

Advertisers' Index 44
Book Reviews 14
Classified Advertising 42
Coming Events 30
Education 38
Equipment and Supplies 38
IFT News 32
Industry News 36
Literature 39
Packaging 36
People 33

OCTOBER COVER. The 14-ft. Rough Handling Machine simulates treatment that may be received in actual shipments. Packed containers weighing up to 600 lb. tested in a revolving drum slide, tumble and fall freely, striking on faces, edges and corners. Results are recorded as to the effects of shock and stress on the container and its contents. For other aspects of containers, see page 7.

Photo, courtesy of the Package Research Laboratory, Rockaway, N.J.

FROM Planning... TO Canning!



THE FINEST CONTAINERS AND SERVICE COME FROM CANCO!

Canco service starts long before production. Canco operates the world's largest food research laboratory and has unmatched experience in canned food product formulation. Technical Service people are ready to act as your consultants on the proper use and formulation of raw materials, canning methods and equipment, quality control, or any problem relating to the canning procedure.

Canco's can-handling and plant layout engineers are available for assistance. They are experts in increasing speed and efficiency within your plants.

A staff of professional home economists is available to help you develop new products, evaluate proposed or existing products and to develop recipes.

The aim of Canco service is to produce containers that promise you better packaging, fewer production stoppages, lower packing costs. That means a better product ... *more profits for you!*

CANCO Division AMERICAN CAN COMPANY

New York • Chicago
New Orleans • San Francisco

First Undergraduate Scholarships Awarded

Ten Award Winners to Attend Schools in Michigan, Georgia, California, Oregon and New York

"I feel honored to have been chosen for one of the undergraduate scholarships in the program of Food Technology for the coming year. . . ."

"I shall do everything possible to try to live up to the confidence shown in me by the Institute of Food Technologists in granting this scholarship to me. . . ."

These are but two of the expressions of appreciation voiced by recipients of the first IFT Undergraduate Scholarship Awards in accepting the grants offered to attract worthy students to the field of food technology.

Marybeth Martin

A. Doyleen Reed

Brian S. Lent

William Floate

Derald W. Sue

Teryl Beebe

Photographs of Ronald Eriksen, Shirley Grundon, Phil Liston and Sibyl Wright not available at time of publication.

As the Fall term opened at colleges throughout the country ten students—five boys and five girls—each the recipient of a $300 IFT Undergraduate Scholarship Award, were in attendance at five schools in widely separated sections of the country.

A SIGNIFICANT STEP

The IFT Undergraduate Scholarship Awards, granted for the first time this year, represent a significant step in the activities of the Institute of Food Technologists—a step deliberately designed to help qualified students get a start in the field of food technology.

The need for food technologists was clearly demonstrated in an extensive employment survey completed last year by the Institute of Food Technologists. That survey showed that food companies would have hired 61% more food technologists during the last five years *if* they had been available. More importantly, during the *next* five years industry would like to hire more than twice as many food technologists as there are now in training.

In the opinion of Dr. G. C. Jenison, Chairman of the IFT Undergraduate Awards Jury, the granting of the current scholarships represents a modest step—but an important one—in a program that will be accelerated in the years to come. The caliber of students to whom the first awards were made is, in his opinion, of greater importance than the number who were chosen for the scholarships.

RECOMMEND "GREATER EFFORTS"

Following their selection of applicants they offered several observations which may be helpful to other juries and also of interest to IFT members.

Plans to publicize the fact that the scholarships are available have been approved by the Executive Committee and such efforts should result in a greater number of applicants for the scholarships. Notices of the availability of the grants will be sent to trade papers of the industry, employee magazines of companies in the food industry and through other means. Through a concentrated effort of the Sections and individuals, much can be done to publicize the fact that ten $300 scholarships are available each year to qualified students who are entering college for the first time and who are interested in "pursuing a curriculum in the field of Food Science and Food Technology."

For the benefit of those who would like to stimulate interest in the scholarship program, and may be unfamiliar with the procedures, it should be pointed out that applications should be "made on the official form to the Head of the Department of the approved college." (Applicants must request the approved form.) The Department Head may nominate a maximum of four applicants in any one year by endorsement and recommendation, indicating his personal preferences, if any.

MAY CHOOSE ALTERNATES

Applications on the prescribed forms are then submitted to the Executive Secretary of the Institute who will then direct them to the Awards Jury. Ten selections for scholarships are then made and a maximum of 10 alternates may be made if, in the opinion of the Jury, they are qualified. The alternate selections must be placed in order of priority.

Dr. Jenison's Committee recommended that applicants for the IFT scholarships should not be con-

sidered unless they are in the first 25% of their class and further suggested that department heads should rate their applicants and so indicate in the letter accompanying their selections.

Members are urged to make the availability of the scholarships known to students of their acquaintance, to those attending Career Day programs and to publicity sources in the areas in which they live.

NAME AWARD WINNERS

There are 10 "Charter Members" in the "pilot plant" operation of the IFT Undergraduate Scholarship Awards program. Brief sketches of each follow:

William Floate, 18, Benton Harbor, Michigan, will attend Michigan State University in East Lansing. He played football, was a member of the Varsity Club, an Eagle Scout, a member of the national honor society, Mu Alpha Theta.

Phil G. Liston, 19, who ranked 35th in a class of 258 at Wooster High School in Wooster, Ohio, also chose to attend Michigan State University.

Marybeth Martin, 18, of Decatur, Georgia, will attend the University of Georgia at Athens. She, too, was active in extracurricular affairs including the national honor society. Her high school principal commented that she was "intellectually curious" and credited her with having made an "outstanding record."

Sibyl Elois Wright, 18, of Athens, Georgia, will attend the University of Georgia in that city. She held various class offices and spent last summer as a laboratory assistant in food technology at the University.

Doyleen Reed, 17, of Davis, California, chose to attend the University of California branch in that city. She held numerous class offices, ranked 8th in a class of 114, and was rated superior in the biological sciences.

Also attending the University of California at Davis is Shirley Beth Grundon, 18, of West Sacramento, California. Scholastically she ranked as "top junior girl" last year and this year won the Bank of America Achievement Award.

Three awards winners chose to attend Oregon State College at Corvallis. They are Teryl Patricia Beebe, 18, of Lebanon; Derald Sue, 19, of Portland; and Brian S. Lent, 18, of Hebo, Oregon.

Miss Beebe attended Sweet Home Union High School of Sweet Home, where she won "outstanding student" awards in geography, English and health, was secretary of the honor society, a member of the swimming team and ranked 6th in a class of 136.

Derald Sue, who attended Washington High School in Portland, was president of the national honor society, won honors as the "outstanding Science senior" and ranked 16th in a class of 280.

Lent, who ranked 3rd in his class of the Nestucca Union High School of Cloverdale, was a member of the national honor society and held class offices throughout his high school career.

Ronald Lee Ericksen, 18, of Jackson Heights, N. Y., is attending Cornell University in Ithaca. He is a graduate of Newton High School in Elmhurst, N. Y.

Containers for Refrigerated Warehouses

Cliff D. Carpenter
Cliff D. Carpenter Associates

FOR EVERY single solid advance made in package development, dozens of package research projects are discarded for a multiplicity of reasons. This is an expensive matter, but any company that would be successful must continue spending heavily for research development.

Containers are becoming increasingly important to warehouseman, processor, and retailer alike because of the rapid changes constantly taking place in food processing, refrigeration, transport, and distribution.

Today's warehouseman can be virtually certain of change. While he is following current practices, containers continue to go through many changes and his operation must remain flexible enough to meet them.

Most of the recent innovations in containers have been stimulated by the major factors of automation, further processing, convenience foods, and the use of paper and plastics instead of wood and metal.

Steady increases in labor costs have brought striking advances in automation, which in turn have affected the warehouseman. For example, palletizing further-processed commodities at the plant and delivering the palletized products to the warehouse, or yet again delivering them in case lots within a master container will require different warehouse handling techniques.

The further processing of raw commodities is affecting size and other container characteristics. This trend appears to be working to the advantage of the warehouseman because package sizes are becoming more uniform. However, greater emphasis should be placed on the oblong instead of the cube package because it stacks better. This assists materially in the necessary arrangement for the freezing process.

Cooperative Action Urged

At least one serious problem related to the freezing process remains unsolved: how to produce non-slipping containers that are highly resistant to moisture. Additional research is badly needed in this vital area. The Refrigeration Research Foundation has made an excellent effort to bring the importance of this problem to the attention of processors and container manufacturers, but much persuasion is still necessary to bring about the desired action.

It is imperative that such organizations as the Refrigeration Research Foundation, and the National Association of Refrigerated Warehouses maintain very close liaison with food processors, mainly through their commodity trade associations, so that the facts on package failure are placed squarely before the top executive of each processing firm. Until this is done, the trucker, the warehouseman, and the retailer will continue to absorb losses due to package failure.

Poultry Container Developments

An example of package failure comes from Western European importers of frozen chickens and turkeys who are reporting that these products, packaged in paper containers, are arriving in a seriously damaged condition. This results in: added labor cost for rehandling; damage to the product; spillage; and large pilferage losses. The answer lies in better shipping containers so that the product is protected all the way to the market.

Package Research Laboratory of Rockaway, New Jersey, has recently developed two containers for turkeys (T Box), and broilers (B Box). These boxes overcome fatigue and failure, minimize pilfering, and permit unlimited stacking. They have been approved by both the USDA Poultry Inspection Service, and the Foreign Agricultural Service, which administers the Public Law 480 program in about twenty free countries.

It is estimated that the T box will add about one-fifth cent a pound to the cost of 50 pounds of turkeys —or about 10 cents over the lower-priced corrugated container—and is fairly competitive with the best corrugated boxes.

Turkey Box; popularly known as the "T" box. Separate, inexpensive corrugated tray and four-section wirebound mat fit most freezing requirements, permit safe handling and high stacking.

The cost of the B box is comparable to two one-dozen paper boxes.

Overseas test shipments are now being conducted on both the T and B boxes, and the results will be carefully checked and reported.

Ten years ago practically all the turkeys raised in the U. S. were packed in wirebound boxes. In 1960, 83 million birds moved in 30 million cartons, and wirebounds carried practically none.

Vitamin A man

Walter Dutton is foreman of our shipping department. It's not the kind of job a man can go through with his eyes closed. Almost seems that no two customers for our *Myvax® Vitamin A Palmitate* or *Acetate* want their shipments the same way. And why should they? Each customer has his own geographical problems, his own production and stock-keeping practices and policies, even his own emergencies. It's up to us to meet *his* convenience. We do. Anything we can do for you on vitamin A?

Distillation Products Industries, Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies, Inc., West Coast • Charles Albert Smith Limited, Montreal and Toronto.

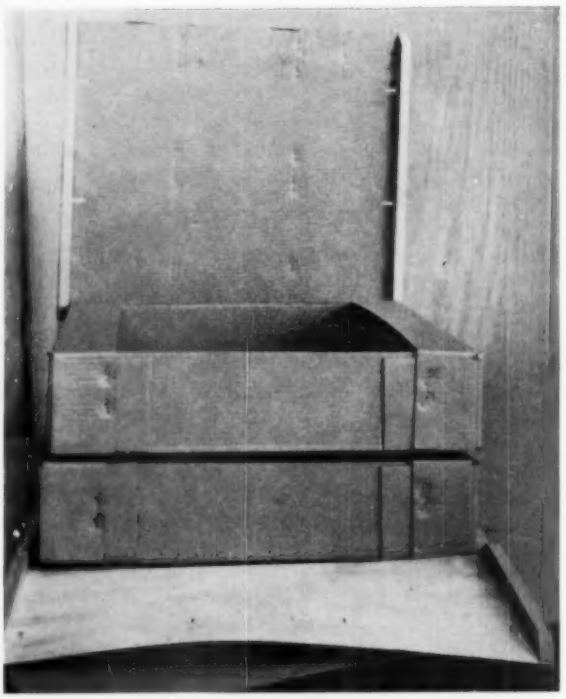
DPi

leaders in research and production of vitamin A

Distillation Products Industries

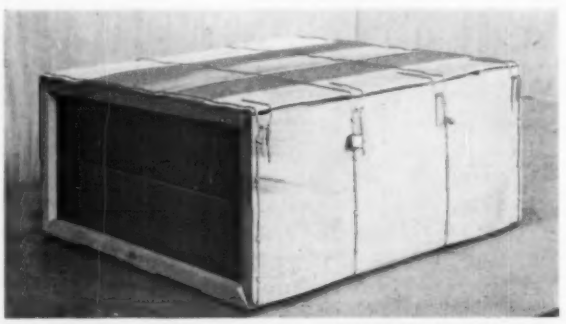
is a division of **Eastman Kodak Company**

The newly designed Package Research Laboratory wirebound T box for frozen turkeys promises to change the picture. The Laboratory claims that its T box performs under the most severe conditions where cartons are failing, and that it should be competitive in cost with all but the simplest of corrugated packages.



Broiler box, Rockingham size, showing trays in position on mat.

Though warehousemen have stated that frozen turkeys represent only about 5 percent of their storage holdings, they are quick to complain that these holdings constitute 95 percent of their problems because many paper boxes used for packing turkeys will fail if stacked for several weeks. And another factor in the problem is the use of paper containers for raw commodities, such as whole or split turkeys and chickens, that do not support the box.



Broiler box, Rockingham size, completely closed. Note: Two different types of seals are shown on wire closures.

why do so many buy **Myverol** emulsifier?

What counts is the cost per pound of finished shortening, not per pound of emulsifier!

Write for samples of our emulsifier, *Myverol® Distilled Monoglycerides*. Try them in your household-type or baker's shortening. Forget about overage to take care of emulsifier variation. (This emulsifier doesn't vary that much.)

Now, try the shortening in cakes, sweet rolls, frostings. See what improvements you achieve in texture.

Then decide what a good emulsifier is really worth.

Distillation Products Industries, Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies, Inc., West Coast • Charles Albert Smith Limited, Montreal and Toronto.

distillers of monoglycerides made from natural fats and oils

DPi

Also . . . vitamin A in bulk for foods and pharmaceuticals

Distillation Products Industries *is a division of* **Eastman Kodak Company**

The Moisture Problem

The characteristics of dry paper are totally different from those of wet paper. Paper-box makers are attempting to overcome the detrimental effects of moisture by using moisture-resistant coatings and chemical additives to modify the properties of the cellulose fibers, or by substituting synthetic fibers. Increasing the paper weight alone will not overcome the moisture problem.

Some manufacturers of coated or impregnated containers for ice-packed poultry appear to be well on their way to solving the moisture problem. However, it is reported that some of these containers presently cost more than the traditional wirebound box, and that they may not allow for the abundant icing that is so essential on long hauls and in hot weather. Continuing research should produce advances in this area.

Frozen broilers stored in refrigerated warehouse in Rotterdam in paper boxes without wirebound protection.

Package and Container Tests

There is a growing tendency among manufacturers toward comprehensive pilot testing to predetermine if a new package will meet the commercial requirements of performance and economy. Included are trial shipments to distant points, the drop test, and tests on stacking pressure, and vibration.

In the drop test, a container is packed with iron weights and tumbled to find the number of "falls" it can take before showing serious fatigue or failure.

The test for stacking pressure is made with containers to 1,500 pounds in height. They are usually stacked on pallets, where they remain for 7 to 10 days. This test usually exceeds the expected stress.

Vibration tests are used for predetermining damage to both the container and its contents. According to a recent report, "Every package reacts differently—depending on its center of gravity, and the friction between it and its resting surface."

A test that the Military Subsistence Branch of the Quartermaster Corps has under way involves the use of wirebound wrap-arounds for overseas shipments of shell eggs. For years, QMC has experienced a lack of interest in bidding for export eggs because of the wooden-case requirement. Few processors find it profitable to tie up capital in wooden-case inventories on the uncertainty of being awarded a bid. It is expected that the current tests will show that the lighter-weight, less-expensive wirebound wrap-arounds will deliver the eggs in as satisfactory a condition as do the wooden cases, and that this will encourage more processors to bid.

Recent Container Developments

An advance toward solving the warehouse stacking problem comes with the current introduction, by Olin Mathieson, of "Armor-Gard." This is a reinforcement strip to increase stacking strength. It is placed between the corrugated medium and the outer liner to the full depth of the container. The Company is also marketing a built-in center strip as a remedy for package puncture.

The expendable pallet is another new device that should be of interest to warehousemen. It is built of corrugated board in sizes ranging up to $48 \times 48 \times 4$ in., with emphasis on the popular sizes of 32×40 and 40×48 in. The pallet has high compression strength and weighs only about 4 pounds. Shipped flat, it occupies only one-tenth the space of a conventional pallet, and is relatively inexpensive.

A master shipping container for frozen foods was recently designed by Aveo. Measuring $40 \times 40 \times 79$ in. high, with a capacity of 40 cubic feet and weighing 250 pounds, it is insulated with 2 inches of foam poly-urethane. The exterior is made of steel, and the interior of aluminum. The frozen-food container will hold 10 degrees for 2½ hours with 9¾ pounds of dry ice.

The Aveo master shipping container may well be the possible answer to shipping dry groceries along with frozen foods.

Keeping Well Informed

The examples of recent developments cited represent by no means the total picture of all going on in the container field.

Freeze dehydration and the use of liquid nitrogen will probably exert future influences on containers, in both transport and storage. It is too early to make any predictions in this area of development. But it is evident that improvements in containers and materials handling will go forward as dictated by: new inventions; in-plant feeding (especially via vending machines); progress in the fast-moving field of convenience foods; and projected savings in time and labor costs.

Warehousemen interested in keeping well informed about such advances should read at least four trade publications, attend materials-handling shows and meetings, and the annual meeting of the Packaging Institute. The knowledge gained concerning the characteristics of new products and new containers should help the warehouseman operate more efficiently.

IMITATION VANILLA BEAN FLAVOR BY FIRMENICH

Vanilla Bean Flavor by Firmenich stems from the vanilla bean. By original research, its components and desirable characteristics have been isolated, identified, and synthesized. By patient and painstaking laboratory techniques, they have been reconstructed for you in a precise and potent flavor material with all the aromatic qualities of the original.

Vanilla Bean Flavor by Firmenich comes to you as an economical replacement of pure vanilla extract, of pure vanillin, or to use in combination in the manufacture of all products that you flavor with this most popular of flavors. Contains no coumarin.

FIRMENICH & CIE.
SUCCESSEURS DE
CHUIT, NAEF & CIE.
GENÈVE SUISSE

FIRMENICH INCORPORATED
250 WEST 18TH STREET, NEW YORK 11
FIRMENICH OF CANADA, LIMITED,
348 WALLACE AVENUE, TORONTO
CHICAGO OFFICE: 612 NORTH MICHIGAN AVENUE
LOS ANGELES, 1756 MALCOLM AVENUE
GENEVA PARIS LONDON

The Epicurean Touch...

Processed Meats Seasoned With

MAGNA CONCENTROLS

taste better, sell faster because these scientific formulations of spice essential oils and oleoresins are 100% natural flavor obtained from the finest herbs and spices. All of the flavor is released immediately. Your products are uniformly seasoned at all times.

Popular MAGNA CONCENTROLS include:

BOLOGNA No. 128
CORNED BEEF HASH No. 146
FRANKFURTER No. 130
LIVERWURST No. 112
SALAMI (Various types)
SAUSAGE (Various types)
WIENER No. 153

Mail us in confidence a sample of any dry soluble seasoning and we will convert it into a MAGNA CONCENTROL and send you an ample testing sample with instructions for use. No cost or obligation.

Since 1895

MAGNUS, MABEE & REYNARD, Inc.

Essential Oils and Concentrated Flavors

16 Desbrosses Street, New York 13, N. Y.

CALL FOR NOMINATIONS

The Babcock-Hart Award

Any member of the Institute of Food Technologists may submit a nomination for the 1962 Babcock-Hart Award between now and the January 1, 1962, deadline.

To be considered, nominations must be made on the prescribed nomination form, which may be obtained from the Executive Secretary.

Donor of the $1,000.00 and engrossed plaque accompanying the Award is the Nutrition Foundation. Purpose of the Award is: "To honor a person who has distinguished himself or herself by contributions to Food Technology which have resulted in improved public health through some aspect of nutrition or more nutritious food."

To be eligible, a nominee must have made a technological development, or a scientific contribution leading directly to a technological development, which favorably affects the nutritional well-being of the public. **Contributions in clinical nutrition and fundamental scientific studies in nutrition cannot be considered as qualifying according to conditions established by the Donor.**

The Nicholas Appert Award

Any member of the Institute of Food Technologists may submit a nomination for the 1962 Nicholas Appert Award between now and the January 1, 1962, deadline.

To be considered, nominations must be made on the prescribed nomination form, which may be obtained from the Executive Secretary.

Donor of the $1,000.00 honorarium accompanying the Award is the Institute of Food Technologists. The Award, originated by the Chicago Section, also includes a Bronze Medal, which is donated by that Section. Purpose of the Award is: "To honor a person for pre-eminence in and contributions to the field of Food Technology."

Qualifying criterion for a nominee includes merely the fact that the nominator considers the individual so pre-eminent in the field of Food Technology that he or she should be acclaimed for contributions thereto. This precludes consideration of personality or other characteristics outside the field of contributions to Food Technology, for such factors may not be considered by the Awards Jury in making the selection.

CONTINENTAL SCIENTISTS WHO WORK FOR YOU

When new preservation methods are developed Continental customers get them first

Keeping canned foods tasty, wholesome and nutritious is an important responsibility of the microbiologist at Continental's Metal Division Research and Development Center. He uses his background knowledge of spoilage factors to control quality standards in food preparation, processing and packaging.

This knowledge encompasses both the desirable changes brought about in foods by microbes—such as the fermentation of cabbage, starch and sugars—and the undesirable changes connected with spoilage. The microbiologist is actively engaged in the endless search for better means of controlling microorganisms by heat, freezing, acidity, water and sugar content, and, most recently, by atomic energy.

At canners' technicians schools sponsored by the N.C.A. and state canners associations, Continental microbiologists train analysts in the latest quality control procedures. They also assist packers with bacteriological problems, conduct bacteriological plant surveys and make quality control recommendations.

As a Continental customer, you can be sure that the best in scientific manpower, facilities and equipment are always working in your behalf.

CONTINENTAL CAN COMPANY

Eastern Division: 633 Third Avenue, New York 17
Central Division: 135 S. LaSalle St., Chicago 3
Southern Division: 905 Florida Ave., Tampa 2
Pacific Division: Russ Building, San Francisco 4
Canadian Division: 790 Bay St., Toronto 1

BOOK REVIEWS

THE MERCK INDEX, Paul G. Stecher, editor. xi + 1642 pages. Merck and Co., Inc., Rahway, New Jersey. Seventh ed., 1960. $12.00.

The Merck index of chemicals and drugs is rightfully represented as an encyclopedia for chemists, pharmacists, physicians, and members of allied professions. The format of the seventh edition is essentially the same as the sixth edition (1952). The new edition is enlarged, however, to accommodate descriptions of new chemical entities, expansion of the Cross Index of Names, increased indications for medical and veterinary uses, and addition of more toxicity data on various compounds. Particularly attractive are the thorough and separate Cross Index of Names including synonyms, trade names, and manufacturers code numbers. Also included are tables on Calories in Foods, Some Biological Units and Their Use, the Russian Alphabet, Roman Numerals, Prescription Notation, Conversion Formulas for weights and measures, Isolonic Solutions, Saturated Solutions, Ion-Exchange Materials, and Chromatographic Adsorbents. There is a substantial increase in the number of structural formulas, which are accurately depicted and of great value. This has necessitated not only an increase of 475 pages over the sixth edition, but also a larger size ($9\frac{7}{8} \times 7\frac{1}{4}$ in.). The monographs on the chemicals include information on recent compounds of scientific interest such as coenzyme Q, and are liberally sprinkled with references to the 1959 literature. Of particular interest to the food scientist are physical, chemical, and toxicological data on a great many food additives and chemicals used in processing. The Merck Index is attractively bound in blue cloth and legibly printed on paper of good quality. The Merck Index is sold without profit, and the publishers, Merck and Co., Inc., are to be commended for this service to science. The price puts The Merck Index within the reach of every laboratory, and it is recommended that no laboratory be without a copy of the new edition.

THOMAS RICHARDSON

MODERN INSECTICIDES AND WORLD FOOD PRODUCTION. F. A. Gunther and L. R. Jeppson, John Wiley and Sons, Inc. 1960. 284 p.

This very attractive, popularly styled text was written by a team of an outstanding entomologist and a pesticide residue chemist. The purpose, according to the preface, is a field review, not a reference text, and it is not written for the specialist in economic entomology or for the chemist. The book deals with poisonous but essential substances (" . . . modern pesticides are essential to man's existence"). The authors have attempted to avoid a catalogic style; in the latter chapters, however, the numerous insecticides and acaricides described made a catalog almost unavoidable. The lack of chemical formulae, although generic names are given, may be excused since it was aimed to keep this text concise and within 300 pages.

The first chapter, on "Insects and Hosts," briefly discusses the ecological factors of the insect population and the effects on plant life. For example, the authors estimate that 10% of agricultural loss is due to insect damage. The yield of cotton with pest control is 475 lb/acre, versus 194 lb without chemical control. Thus, the importance of modern insect control is emphasized.

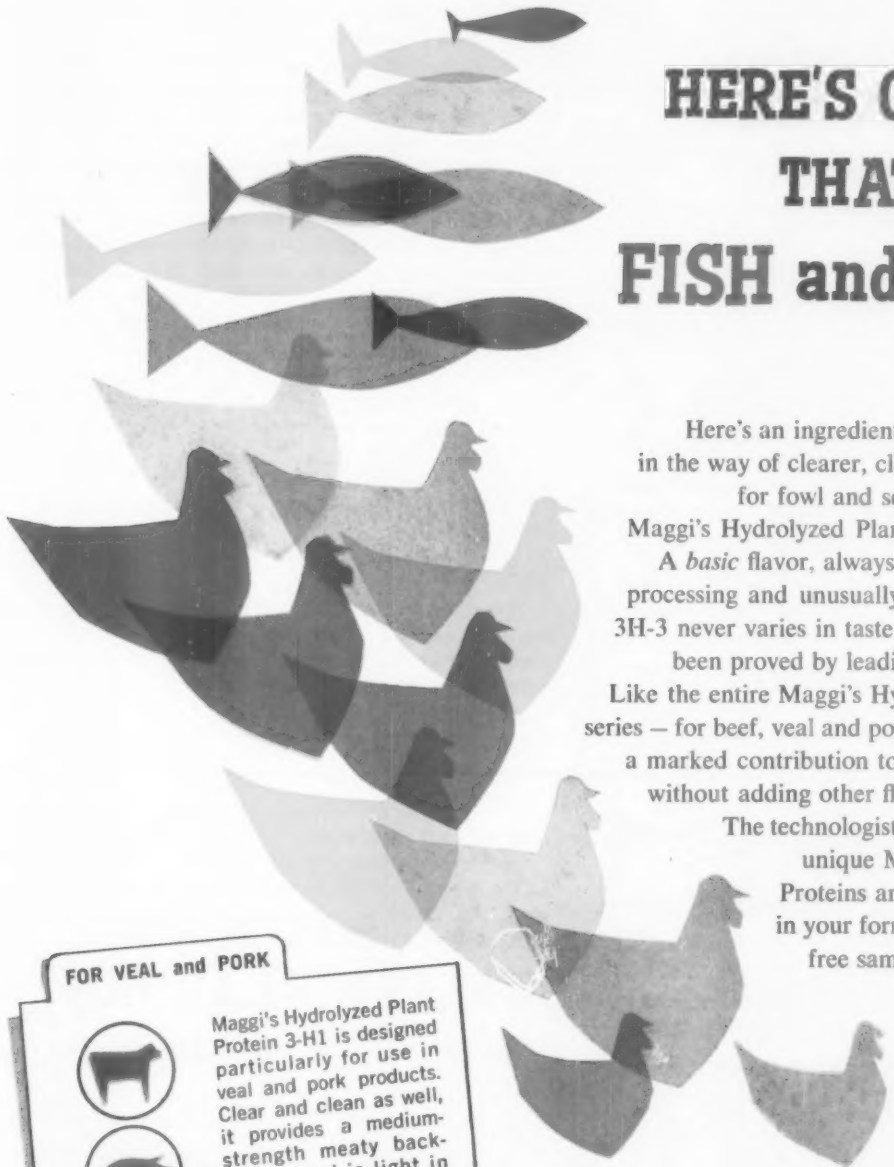
The next chapters discuss various methods of insect control, e.g., chemical, biological, plant breeding etc. Again the loss of crops due to insect damage is estimated at 21 billion dollars per year throughout the world. This is a staggering sum, especially with drought and famine playing additional havoc in many parts of the world. The world production of insecticides is equally impressive, e.g., 125 million pounds of DDT in 1957. It is not surprising, therefore, that these insecticides would accumulate in the soil after repeated applications. These residues may be translocated by plants that are eventually fed to dairy animals, thus resulting in pesticide residue in milk. These problems are not ignored. It is also known that these pesticide residues on agricultural crops are dissipated by chemical and physical transformations. The mechanism of such changes in largely speculative and should be a good field of basic research. Degradation of residues due to plant or fruit growth is barely mentioned.

A brief discussion on the legal responsibilities and legislation is factual. The authors recommended that tolerances should be established on a dry-weight rather than fresh-weight basis. Other statistics are revealing, e.g., the cost of development of a new pesticide may be as high as $1,250,000, discouraging many smaller companies from entering this field. The major share of this cost is carried by the toxicological testing methods. Although these methods receive only scant notice in this book, new concepts of toxicity methodology should be the subject of greatly expanded research by university and government scientists. I take exception to the authors' statement that "before Public Law 518 (Miller Amendment to F.D. Laws), there were no disasters in the U. S. as a result of . . . companies hastening truly dangerous compounds to extensive markets." The last such disaster occurred in 1937, when at least 73 persons died from ingesting "Eliexir sulfanilamide."

The biochemistry of developed resistance to these chemicals receives brief treatment, but again, basic research in the understanding of such resistance (e.g., dehydrochlorinase), and development of new classes of pesticides as well as resistance-reversing compounds point to a more optimistic future.

About one-half of the book describes the most important insecticides and acaricides as well as the pests being controlled. These compounds include organic-chlorine, organic-phosphorus, carbamates, fumigants, biologicals, attractants, and repellants. The description of individual compounds is not detailed enough to serve as a reference book, and thus lessens the importance of these sections beyond some tabular treatment.

MORE THAN A SUBSTITUTE



HERE'S ONE THAT'S BOTH FISH and FOWL

Here's an ingredient that gives you *everything* in the way of clearer, cleaner, better flavor for fowl and sea food products – new Maggi's Hydrolyzed Plant Protein 3H-3.

A *basic* flavor, always uniform, unaffected by processing and unusually economical, Maggi's 3H-3 never varies in taste or quality, has been proved by leading processors.

Like the entire Maggi's Hydrolyzed Plant Protein series – for beef, veal and pork, too – 3H-3 makes a marked contribution to the desired flavor without adding other flavor characteristics.

The technologists who developed these unique Maggi's Hydrolyzed Plant Proteins are available to assist you in your formulations. Write for free samples and data.

FOR VEAL and PORK

Maggi's Hydrolyzed Plant Protein 3-H1 is designed particularly for use in veal and pork products. Clear and clean as well, it provides a medium-strength meaty background and is light in color.

FOR BEEF FLAVOR – MAGGI's 4-BE and 4-BE-2
Available in Liquid, Paste or Powder form

MAGGI'S®
HYDROLYZED PLANT PROTEINS

Prepared by the makers of world famous **MAGGI'S®** *seasoning*

THE NESTLÉ COMPANY, INC.
WHITE PLAINS, N. Y.

Appendices list the toxicities of pesticides (LD_{50} values), the commercial source of pesticides, and the scientific name of pests mentioned in the text.

The illustrations, depicting many "pests at work," are of the highest quality.

This book is highly recommended, especially to workers in the food industry who have been suddenly confronted with "pesticide residue" problems and wish to know how the problems originated.

GUNTER ZWEIG

AN INTRODUCTION TO THE THERMAL PROCESSING OF FOODS, Vol. 1, by S. A. Goldblith, M. A. Joslyn, and J. T. R. Nickerson. 1128 pages. The Avi Publishing Company, Inc., Westport, Conn. $16.50.

Most of the basic papers that form the foundation for the science and technology of canned-food processing have been out of print for many years, much to the regret of workers in this field. Much of the early work was published in the form of bulletins rather than in scientific journals, and these have been unobtainable except in a few libraries. In the present volume many of these papers are brought together, starting with Appert's epoch-making work (Bitting's translation): "The book of all households, or the art of preserving animal and vegetable substances for many years."

The book is divided into four sections. The first, "Microbiological aspects" (22 pages), includes the pioneering work of Prescott, Underwood, and Russell on spoilage in corn and peas, which led to the initial classification of spoilage thermophiles and then to the development of thermal death-time techniques by Esty, Cameron, Bigelow, and others, with Bigelow's establishment of the logarithmic nature of the thermal death-time curve. Also included are the classical studies on botulism and the heat resistance of *Clostridium botulinum* spores, by Dickson, Meyer, and Esty, which formed the basis for the establishment of process levels for low-acid canned foods. The early work of Berry and others on *Bacillus thermoacidurans*, and the investigation of heat-resistant molds, by Olliver and Smith, and Williams *et al.*, are also here. A minor criticism is that Howard's two papers on the development of methods for counting mold in tomato products hardly belong in a collection on thermal processing, but nevertheless it is good to have them reprinted.

The second section (7 papers) includes papers on the development and application of techniques for measuring heating rates in canned foods (particularly noteworthy is the pioneering work of Bigelow and

others) and on the development of the plug-in thermocouple by Ecklund. Bigelow *et al.* established the characteristics of the heating curves in a variety of canned products and worked out the general or graphical method of process calculation that has been the foundation for all subsequent work in this field.

Section III (5 papers) is devoted to studies on the calculation of processes for canned foods, starting with Ball's original work on mathematical methods and continuing with Olson and Stevens' development of nomograms, Stumbo's paper on death-date curves for bacterial spores, and Hicks' analysis of the various methods of process calculation.

In Section IV there are five papers on commercial applications, including Martin on the aseptic canning system, Wilbur on continuous rotary cookers, and Clifcorn *et al.* on end-over-end agitation.

The editors of this compilation expect that it will be valuable in the training of students in food science, but everyone working in the field of food processing should have a copy because many of the papers are of much more than historical interest. It was a pleasure to this reviewer to see so many familiar and valuable papers in print again.

C. T. TOWNSEND

FOOD ENZYMES, edited by H. W. Schultz, The Avi Publishing Co., Inc., 1960. 136 pp.

This small volume is a compilation of papers presented at the first of a series of symposia held on food at Oregon State College. The purpose of this conference was not only to summarize the data and theories about the role that enzymes play in food processing and in food quality but also to delimit some of the important areas where additional work remains to be done. In both of these aims the participants have done a very creditable and stimulating job.

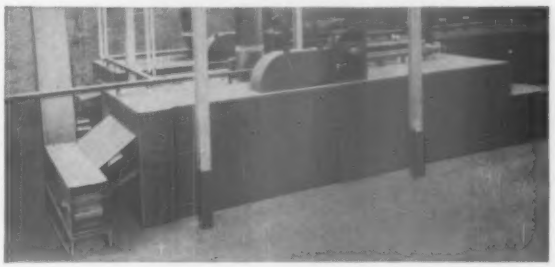
The invited speakers, all recognized authorities, write with charm and enthusiasm. The papers range from fairly complete papers, such as the chapters by Cheldelin and Ponting, to fairly short summaries.

It is interesting that many of the speakers stressed the importance of the organization of enzyme systems into cell structures, such as the microsomes and mitochondria. David Green, in a stimulating chapter that sets the tone for the meeting, not only surveys the reasons for the explosive development of enzymology but also indicates that the problems in unraveling the details of the organization of enzymes in these cell structures will make future progress less dramatic.

Vernon Cheldelin gives an excellent survey of the energy-generating cycles of cells. His chapter covers a much wider range of topics than is indicated by the title. Paul Stumpf and Ralph Holman cover the structure of lipids and their role in nutrition. A. K. Balls summarizes one of the theories of the basic structure and action of proteases and then relates some of his recent pioneering work on enzymes. The practical applications of proteases are covered by Schweigert.

A very valuable chapter for food technologists is by J. D. Ponting, on the browning of fruits. Kertesz,

PROCTOR
Continuous
Dehydrators
for food processing



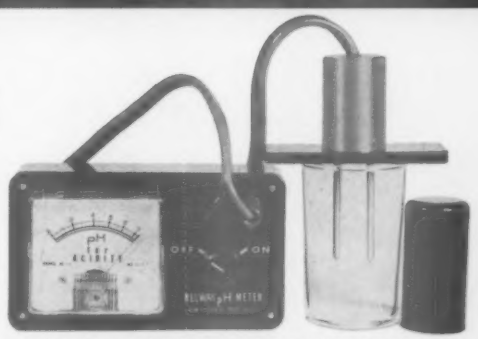
. . . deliver a uniformly high quality product
. . . are designed to fit your process
. . . require less maintenance

Write us—let us prove we can help you with your drying problem.

TYPICAL FOOD PRODUCTS
using Proctor's Continuous Conveyor Dryers:
gelatin, vegetables, starch, fruits, coconut, cocoa beans, cereals, animal foods.

Proctor®
PROCTOR & SCHWARTZ, INC.
Philadelphia 20, Pa.

NOW SPOT-CHECK FOR SPOILAGE WITH FAST, PORTABLE pH METER!



TESTS LIQUIDS OR SEMI-SOLIDS

Now you can spot-check all kinds of liquid or semi-solid matter for acidity quickly . . . easily . . . accurately . . . at low cost, with the new **Kelway** pH METER.

Carry this unit anywhere . . . it weighs only two pounds, is only six inches long, comes in a leather carrying case with handle. Use it anywhere . . . it requires no current, no battery and there are no chemicals to refill. Unlike units using breakable glass electrodes, the **Kelway** pH METER uses two high-purity metal electrodes that test both liquids and semi-solid matter. Use for baked goods, meats, poultry, fish, vegetables, chemicals, etc. Simply insert electrodes in material to be tested and receive a highly accurate pH reading in two to three minutes. Long life. Fully guaranteed. Cost—only **$69.50.** Send to:

KEL INSTRUMENTS CO., INC.
DEPT. FT-1, P.O. BOX 744, NEW BRUNSWICK, NEW JERSEY

FLAVORITISM

...the practice of favoring your product with an Ungerer flavor—True Fruit or Imitation; Liquid or Spray Dried.

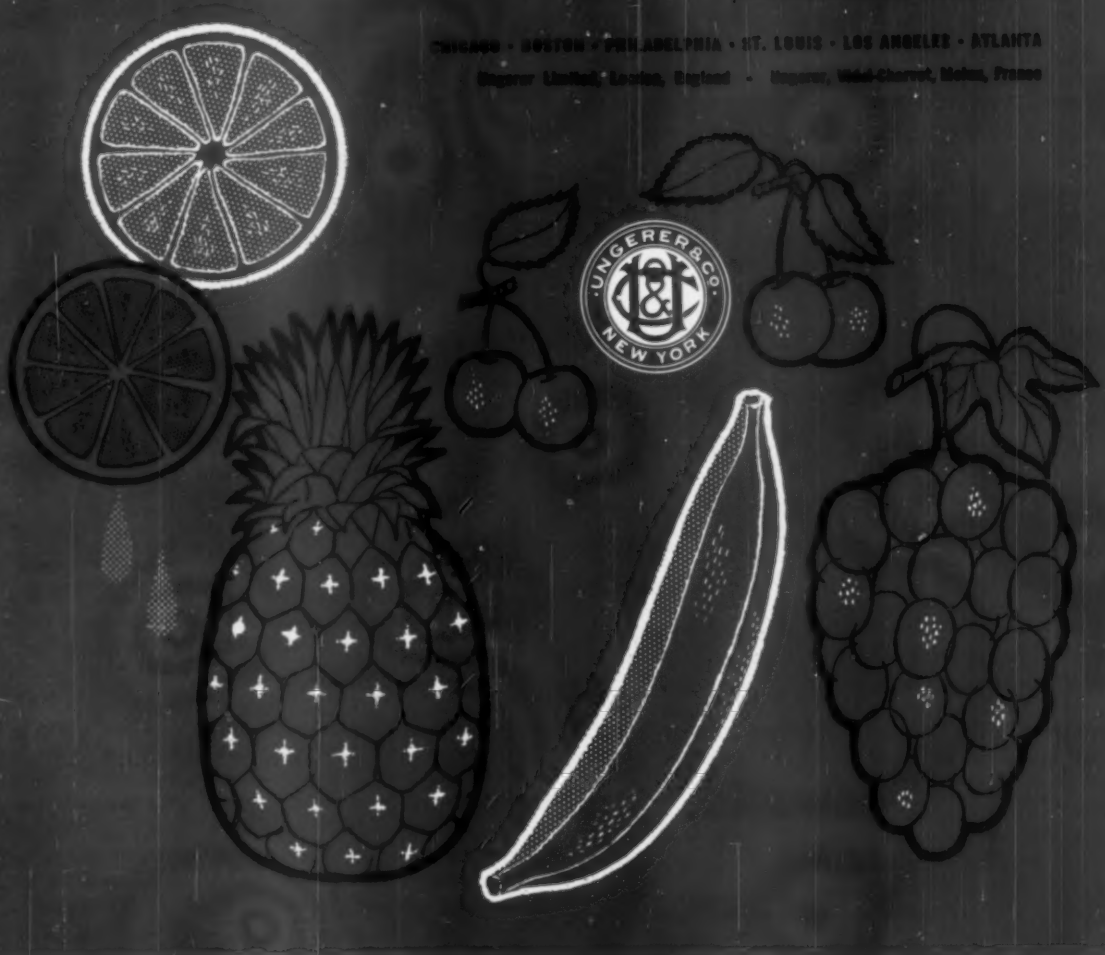
It offers the realistic assurance that your product will be in good taste.

Practice Flavoritism. It's rewarding.

Ungerer & Co.

HOME OFFICE: 161 Avenue of the Americas, New York 13, N. Y.
plant and laboratories Totowa, N. J.

CHICAGO • BOSTON • PHILADELPHIA • ST. LOUIS • LOS ANGELES • ATLANTA
Ungerer Limited, London, England • Ungerer, Wald-Charvet, Melun, France



in his chapter on polysaccharides, emphasizes what many food technologists have discovered: that much still remains to be learned about the synthesis and role of polysaccharides in the plant.

Although much of the material has been covered in previous review works, food technologists will enjoy having a succinct summary of the present status of the role of the major enzymes in their particular fields.

The conversational style makes reading these chapters an easy way to become familiar with the present status of food enzymology.

RALPH M. HEINICKE

MODERN PACKAGING ENCYCLOPEDIA, ISSUE FOR 1961. Modern Packaging Corporation, 575 Madison Avenue, New York 22, New York. 860 pp. Price $3.00.

This is the only reference of its kind in the packaging field. It is also a giant-size commercial directory that combines a useful reference manual with a comprehensive treatment of packaging technology written in easily understandable language.

This attractively designed hard-cover book is printed on superior paper and is filled with examples of the graphic arts, printed appropriately on films, foils, paperboard, and decorated papers. The very numerous advertisements are effectively separated from the technical data by a division arrangement that carries advertising pages pertinent to it and it alone. Advertisers are indexed on the opening page of each division, and classified according to the service they render.

The publishers describe their encyclopedia issue as "a handbook of packaging planned and organized to be completely functional for solving major problems or for answering day-to-day reference needs." Of these two uses, without question, this volume performs the latter well and effectively with a minimum of time; but the former is open to question because it does not necessarily offer final solutions for packaging problems, which often have as many variables as there are users of packaging materials. However, it does narrow the choice of possible materials or equipment for a specific application and it does indicate where detailed technical information can be obtained.

The organization of material for this wide field is well thought out and comprehensive, though some details are sacrificed. Many sections are written by qualified and experienced men who are active in the particular field which they are describing,

Of particular timeliness is an article on packaging materials in relation to the Food Additives Amendment of the Food, Drug and Cosmetic Act. The current status is reviewed, together with the general procedure necessary before approved status is issued for the packaging material in question.

Great care has been exercised in categorizing the multiple variations of materials, machinery, and techniques, which are conveniently described in 6 divisions:

(Continued on page 27 following technical section)

PAD GUMS
QUALITY CONTROLLED
CASEINS
AND CASEINATES

PAUL A. Dunkel AND CO. INC.
IMPORTERS AND EXPORTERS
26 JOURNAL SQ., JERSEY CITY 6, N. J.
TEL: OLDFIELD 6-6400. N. Y.: WORTH 4-3341
CHICAGO: 320 W. OHIO ST. TEL: SU. 7-2462
AGENTS IN PRINCIPAL CITIES
EST. 1914

pH MEASUREMENT
with the PHOTOVOLT 115

Helps Insure Quality— Flavor Texture Purity

COMPLETE WITH SINGLE ELECTRODES OR PROBE
$175

Get this full-fledged pH Meter of remarkable accuracy and stability — simple in operation and maintenance — fast and dependable in service.

Write for Bulletin #225
PHOTOVOLT CORP.
1115 Broadway New York 10, N. Y.
Also available: Complete line of pH Meters ■ Reflection and Gloss Meters ■ Densitometers ■ Recorders

GROWING PAINS

The Annual Meetings of the Institute of Food Technologists, like those of other scientific organizations, are suffering from growing pains. On the one hand, the increasing numbers of research scientists submit each year a greater number and variety of papers for presentation at the annual meeting. On the other hand, the membership, or at least its more vocal segment, demands a limitation on the number of papers and concurrent sessions. Program committees are asked to select the "high-quality" contributions for scheduling.

The objective of highlighting significant research in the program may be met in part by inviting outstanding food scientists to review their work or to participate in carefully organized symposia or panel discussions. Such arranged programs are real aids in keeping us abreast of rapidly expanding knowledge. However, the annual meeting is and should continue to be the forum to which young and obscure as well as experienced and distinguished scientists may bring their research contributions, and defend their ideas.

If a substantial fraction of the contributed papers is to be eliminated from the program in order to hold the number of concurrent sessions within fixed limits, how is the selection to be made? The program committee will have a difficult task under the best of conditions. It cannot exercise valid judgments of the relative merits of contributions on the basis of titles alone, or of titles supplemented by vague, uninformative abstracts.

You can help to improve the quality of annual-meeting programs in several ways. If you are contributing a paper, submit the relevant information and abstract as early as possible so that the committee can foresee the need for organizing special sessions related to your interest in time to do something about it. Put some extra thought on your abstract. In some ways it may be the most important section of your paper; it will be more widely printed and scanned than the paper itself.

When you attend the Miami meetings, take the few minutes necessary to evaluate the sessions that you attend. Mrs. Lois Sather is preparing evaluation cards and working out procedures to ensure a sufficient number of returns for each session. You will hear more about this later.

Dr. Harry Goresline is making a study of the measures taken in other professional societies to cope with expanding annual-meeting programs. Should the subjects discussed at any one annual meeting be limited and changed each year? Should authors be asked to submit completed manuscripts to the program committee? Have you knowledge of practices in other professional meetings that might prove successful at IFT? Send your experience and suggestions to Dr. H. E. Goresline, Quartermaster Food and Container Institute, 1819 W. Pershing Road, Chicago 9, Illinois.

BETTY M. WATTS
Program Chairman, 1962

SPECIAL SESSIONS TO BE SCHEDULED

In the final analysis, the subject and content of the sessions to be scheduled at the annual meeting will be determined largely by the research papers contributed by the membership. The committee has tentatively planned the following sessions, to be organized by the persons designated. Most of these sessions will feature one or more invited reviews as well as contributed research papers. Abstracts of contributed papers that seem to fit under any of these topics may be mailed either to the person listed below or to Dr. Betty M. Watts, Program Chairman. The tear sheet should go to Dr. Watts.

Basic researches on food components (lipids, proteins, flavors, enzymes, etc.). These will be organized into appropriate sessions by Dr. Harold Olcott, Dept. of Nutrition and Home Economics, University of California, Berkeley.

Microbiology and public health. Dr. Clarence F. Schmidt, Continental Can Co., 1350 W. 76th St., Chicago 20, Ill.

Bacterial fermentation in food production. Dr. Charles F. Niven, American Meat Institute Foundation, 939 E. 57th St., Chicago 37, Ill.

Sensory Evaluation Methodology. Mrs. Lois Sather, Oregon State University, Corvallis, Oregon.

Textural measurements and instrumentation in quality control. Dr. Amihud Kramer, Dept. of Horticulture, University of Maryland, College Park, Maryland.

Synthetic flavors. Dr. John F. Mahoney, Merck & Company, Rahway, New Jersey.

Food additives. Dr. Margaret Ives, 801 S. Cook St., Barrington, Ill.

Citrus products. Dr. Robert W. Kilburn, Florida Citrus Canners Coop., Lake Wales, Fla.

Fishery products. Dr. Ernest A. Fieger, Dept. of Agr. Chem. and Biochem., Louisiana State University, Baton Rouge 3, La.

First Call For Contributed Papers

IFT 22nd ANNUAL MEETING

MIAMI BEACH, FLORIDA

JUNE 10-14, 1962

DEADLINE FOR TITLES AND ABSTRACTS . . . . . JANUARY 15, 1962

All IFT members are cordially invited to submit original research papers dealing with any aspect of food science or technology, for the consideration of the 1962 Program Committee. Please use the tear form below to submit titles and other pertinent information as soon as possible.

Abstracts should be submitted in *triplicate* either with the tear sheet or at any subsequent time before the deadline. Use regular $11 \times 8\frac{1}{2}$" paper and give title and author(s) on the abstract sheet. The abstract itself should be **double-spaced** and not more than 250 words in length. It should be a concise but accurate and informative summary of the results and conclusions as well as the objectives of the research.

Manuscripts may be submitted as soon as completed to Dr. George Stewart, Editor of *Food Science* and *Food Technology*, so that the papers may be reviewed and cleared for publication following the meeting. All papers not previously submitted to the Editor must be turned over to the chairman of your session at the annual meeting.

TEAR SHEET—CLIP AND MAIL TO:

DR. BETTY M. WATTS, Program Chairman
Dept. of Food & Nutrition
Florida State University
Tallahassee, Florida

Title:

Author(s)
(Circle IFT members, underline person who will deliver paper).

Address:

Abstract: Indicate if mailed to another committee member_____

Time required. _____ min. (No contributed paper will be allotted more than 20 minutes, including 5 minutes for discussion. If you can present your material adequately in less time, please indicate.)
Facilities needed: 2×2" slide projector ( ), $3\frac{1}{4} \times 4$" slide projector ( ), blackboard ( ), other

_____

I have read the IFT regulations (above) regarding papers to be presented at annual meetings and agree to abide by these terms.

_____
Signature

(over)

RULES GOVERNING PAPERS PRESENTED AT ANNUAL MEETINGS

• No submitted paper shall be presented at an Annual Meeting unless at least one of the authors is a member in good standing of the Institute of Food Technologists.

• No paper shall be presented at an Annual Meeting which has previously been given before other group(s), or which has appeared in print prior to the Meeting.

• The Institute shall have first right to publish papers presented at an Annual Meeting of the Institute. However, after a paper has been accepted for the Meeting program, the author may, with supporting evidence, request its release, either before or after oral presentation. Under no circumstances shall release, if granted, permit publication of the paper before the oral presentation. Within fewer than 60 days after receiving a request for release of and the complete manuscript, the Institute through the Executive Editor of its publications shall give the author a decision to release the paper or to accept it for publication subject to the necessary editorial revision. If accepted, the author or authors shall assign all rights in the paper to the Institute, and after publication, the Institute shall, upon request, reassign all rights back to the author or authors.

Y'ALL COME
MIAMI BEACH '62

Just a reminder. Now is the time to start thinking about attending the 22nd Annual Meeting, at Miami Beach, June 10–14, 1962.

After attending sessions and looking over the exhibits, you are sure to enjoy relaxing in Miami Beach and the world-famous Fontainebleau and Eden Roc Hotels. You might want to make attendance at this Annual Meeting part of your vacation. More later. We'll be looking for you—so Y'ALL COME!

To assist the Program Committee in scheduling, please check all categories below which apply to your contribution.

Commodity

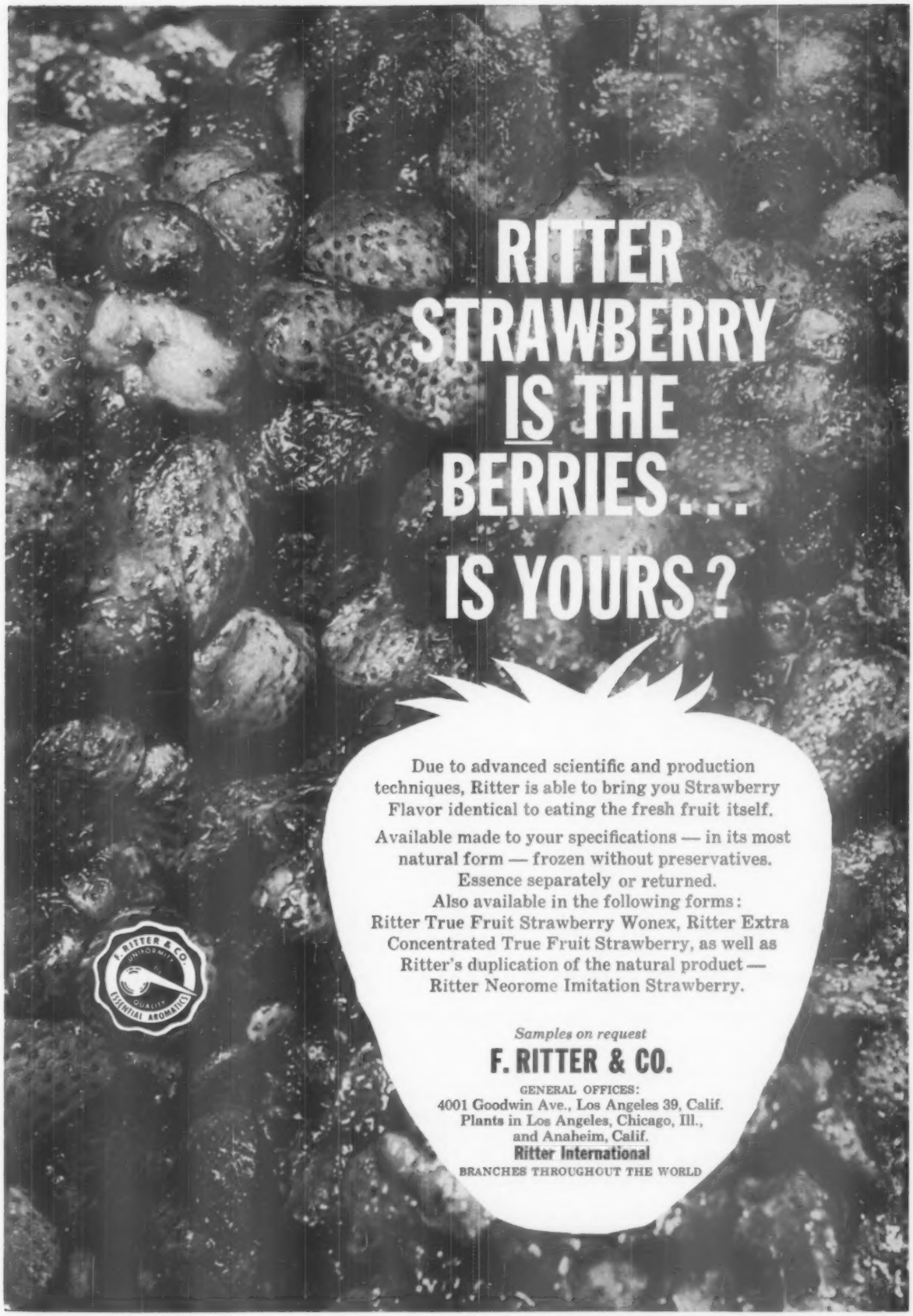
- ☐ Meat
- ☐ Fish
- ☐ Dairy
- ☐ Eggs
- ☐ Fruits & nuts
- ☐ Vegetables
- ☐ Fats & oils
- ☐ Cereals, starches
- ☐ Sugars, confectionery
- ☐ Other

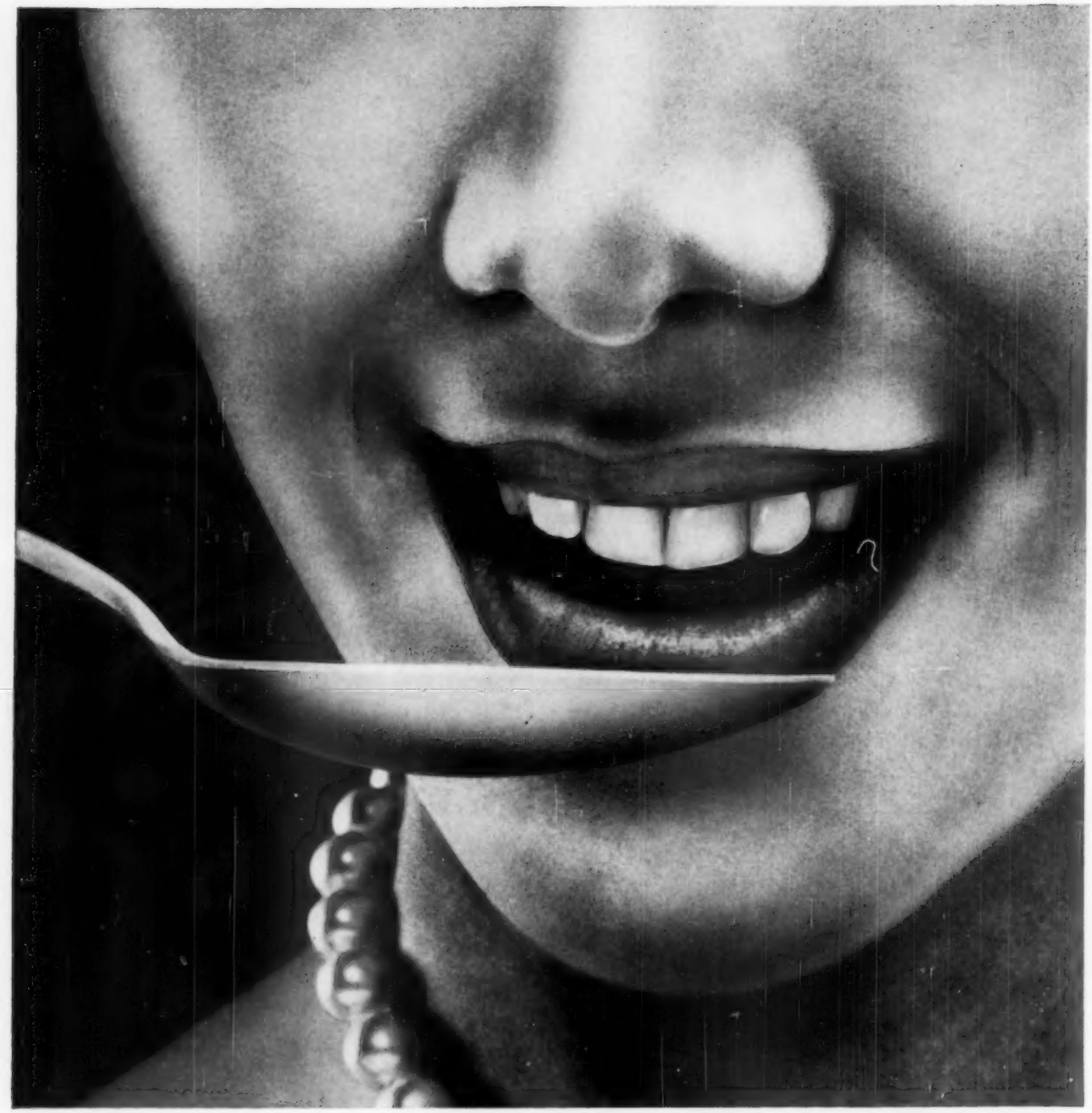
Processing

- ☐ Refrigeration
- ☐ Freezing and dehydrofreezing
- ☐ Canning
- ☐ Dehydration and freeze drying
- ☐ Radiation
- ☐ Brining
- ☐ Cooking
- ☐ Packaging
- ☐ Curing
- ☐ Distribution
- ☐ Other

Aspects emphasized

- ☐ Biochemical, (underline proteins, lipids, carbohydrates, enzymes, pigments, flavors)
- ☐ Biophysical
- ☐ Nutritional
- ☐ Microbiological
- ☐ Morphological
- ☐ Rheology, texture
- ☐ Sensory evaluation
- ☐ Quality control
- ☐ Engineering, apparatus
- ☐ Economics
- ☐ Other


RITTER
STRAWBERRY
IS THE
BERRIES...
IS YOURS?
Due to advanced scientific and production techniques, Ritter is able to bring you Strawberry Flavor identical to eating the fresh fruit itself.
Available made to your specifications — in its most natural form — frozen without preservatives.
Essence separately or returned.
Also available in the following forms:
Ritter True Fruit Strawberry Wonex, Ritter Extra Concentrated True Fruit Strawberry, as well as Ritter's duplication of the natural product — Ritter Neorome Imitation Strawberry.
Samples on request
F. RITTER & CO.
GENERAL OFFICES:
4001 Goodwin Ave., Los Angeles 39, Calif.
Plants in Los Angeles, Chicago, Ill., and Anaheim, Calif.
Ritter International
BRANCHES THROUGHOUT THE WORLD



IMPROVE FLAVOR AT RETORT TEMPERATURES WITH STABILIZED HVP-PROZATE

If you process meats, soups or other canned goods that are subjected to high retort temperatures, look to HVP-Prozate for heat-stable flavor.

Prozate® is a hydrolyzed vegetable protein flavoring agent that has been specially stabilized to withstand high temperatures. It is derived from plant protein and imparts either a rich, meaty flavor or a pleasant background flavor, depending on concentration. Prozate is easy to use, can be quickly incorporated into your present formula, and a little goes a long way.

In addition to HVP-Prozate, Hercules offers a full line of other HVP® products tailored to meet the specialized needs of the food industry. For details about Prozate and a sample of it—or for technical help—write to Hercules.

HERCULES POWDER COMPANY

CHS1-2

Cellulose & Protein Products Department • Hercules Tower, 910 Market Street, Wilmington 99, Delaware

Relation of Gamma-Ray Emission to the Lean Content of Beef Rounds[a]

R. Kulwich, L. Feinstein, and C. Golumbic

U. S. Department of Agriculture, Agricultural Marketing Service, Field Crops and Animal Products Branch, Beltsville, Maryland

and

W. R. Seymour, W. R. Kauffman, and R. L. Hiner

U. S. Department of Agriculture, Agricultural Research Service, Meat Quality Laboratory, Beltsville, Maryland

(Manuscript received May 10, 1961)

SUMMARY

The relation between the low level of gamma-ray radiation emitted and the composition of beef rounds was studied. These rounds came from 6 bulls, 6 steers, and 4 heifers. The amounts of gamma-ray radioactivity arising from naturally radioactive potassium-40 and from the fission product cesium-137 were measured with a plastic scintillation detector. If other gamma-ray emitters were present, their emission was reflected in terms of their contributions to the channel settings used for cesium-137 and potassium-40. The rounds were then dissected into separable lean, fat, and bone. There was a highly significant negative correlation between percent of separable fat and disintegrations per minute from K^{40} per pound of intact round ($r = -0.865$; sample standard deviation from regression, 1.65%). The correlation of percent separable lean with disintegrations per minute from potassium-40 per pound of intact round was also highly significant ($r = 0.798$; sample standard deviation from regression, 2.10%). The cesium-137 gamma-ray emission of the intact rounds was 2.04 ± 0.40 disintegrations per second per pound (mean $\pm$ sample standard deviation).

THE PROBLEM of estimating the lean and fat content of meat is of great concern to the meat industry. The present study was made to examine the relation between the gamma-ray emission of intact beef rounds and their composition.

A study involving gamma measurements of intact hams (Kulwich *et al.*, 1960b) revealed a highly significant relation between net counts per minute from potassium-40 and pounds of separable lean. Kirton *et al.* (1960) studied the relation between K^{40} gamma-ray measurements of 10 lambs and their composition. The correlation of estimated potassium content of the live unwashed lamb with percent carcass fat was highly significant ($r = -0.79$), whereas the correlation of estimated potassium content with percent carcass lean was not significant. Cheek and West (1955) studied the carcass composition of 30 rats and found that total potassium exhibited a simple linear relation with lean body mass. Swift and Berman (1959) determined the potassium and protein content of 8 muscles from two cows, a bull, and a heifer, and found a highly significant correlation between potassium and protein content ($r = 0.937$).

EXPERIMENTAL PROCEDURE

Table 1 shows the breed, sex, and age of the animals from which beef rounds were obtained. This group of animals ranged from 11 to 18 months old and included 6 bulls, 6 steers, and 4 heifers. After the carcasses were chilled, they were divided into cuts. One round (with rump and hind shank removed) was obtained from each carcass for this study. The fresh intact rounds were enclosed in polyethylene bags and weighed.

The gamma-ray emission of the individual rounds was measured in a gamma-ray detector previously described (Pringle and Kulwich, 1961). Concurrent measurements of gamma radioactivity were made at two channel settings. The upper channel was set so that it primarily measured potassium-40 gamma rays, with a small spill of counts from cesium-137. The lower channel was set so that it would measure cesium-137 gamma rays, with some spill of counts from potassium-40. Cesium-137 is a fission product reported widely in foods (Anderson *et al.*, 1957). The gamma-ray measurement data were adjusted for the effect of sample weight on counting efficiency, and for fluctuations in the counting efficiency of the detector on the basis of measurements carried out with standards containing known amounts of cesium-137 and potassium chloride. The potassium chloride standards contained a fixed amount of potassium chloride mixed with varying amounts of granulated sugar in cardboard cylinders. The cesium-137 standards were made up of a fixed amount of cesium-137 standard solution with a varying amount of distilled water contained in plastic bottles. Ideally, the standards should have the same density, shape, mass, and average atomic number as the unknowns (Anderson, 1959). The potassium-40 values may be expressed in terms of total potassium by the use of the gamma-ray disintegration rate value of 194 gamma rays per minute per gram of potassium (Wetherill *et al.*, 1956). After the appropriate adjustments were applied, the results were expressed in terms of potassium-40 and cesium-137 gamma-ray disintegrations. If the samples contained other gamma-ray emitters, their emissions would have been indicated in counts contributed to the channel settings used for cesium-137 and potassium-40.

About 42–51 min of counting time were spent on each intact round, and 40 min on background measurements. This resulted in a relative standard deviation for the upper-channel net counting-rate determination ranging from 1.0 to 2.3%.

After gamma-ray measurements were made with the intact rounds, they were dissected with a knife into separable lean, fat, and bone. The gamma-ray emission of a 34-lb composite sample of separable bone from 11 of these rounds was measured. The separable fat and lean fractions from each round were ground separately in a meat grinder, twice through a coarse plate. Then subsamples were ground three times through a plate with holes of 1/16-in. diameter. The ether extract, moisture, and protein contents of samples of the ground separa-

[a] Presented at the Twenty-first Annual Meeting of the Institute of Food Technologists, New York, N. Y., May 10, 1961.

Table 1. Summary of data on bovine round composition and gamma-ray emission.

Breed	Sex	Age (mos)	K^{40} dpm[a]/lb fat-free separable lean	Intact round K^{40}		Percent separable fat	Percent separable lean	Percent separable bone
				dpm/lb of separable lean	dpm/lb of round			
Angus	bull	12	337	343	287	9.3	84.1	6.6
Angus	bull	12	332	374	298	10.8	80.2	9.0
Shorthorn	bull	14	341	352	257	17.2	73.3	9.5
Shorthorn	bull	14	347	337	259	14.9	77.1	8.1
Shorthorn	bull	14	314	324	243	15.9	75.6	8.5
Crossbred	bull	14	333	336	253	16.6	75.3	8.2
Mean ± s.d.			334±11	344±17	266±21			
Coef. of var. (%)			3.4	5.0	8.0			
Hereford	steer	12	316	334	260	16.5	77.9	8.5
Hereford	steer	12	326	360	288	9.6	80.2	10.2
Hereford	steer	12	318	312	244	14.3	78.5	7.2
Hereford	steer	12	316	341	274	10.6	80.2	9.2
Angus	steer	12	340	343	279	10.2	81.5	8.3
Angus	steer	13	344	354	277	11.2	78.2	10.6
Mean ± s.d.			327±12	341±17	270±16			
Coef. of var. (%)			3.8	5.0	5.9			
Angus	heifer	11	360	356	308	6.2	86.5	7.3
Angus	heifer	12	330	358	289	10.0	80.9	9.2
Angus	heifer	13	346	332	268	9.6	80.9	9.6
Angus	heifer	18	322	346	264	15.0	76.4	8.6
Mean ± s.d.			340±17	348±12	282±20			
Coef. of var. (%)			5.0	3.4	7.1			
For all 16 bovines:								
Mean ± s.d.			333±13	344±15	272±19	12.2±3.2	79.8±3.4	8.7±1.1
Coef. of var. (%)			4.0	4.4	7.0	26.1	4.2	12.4

[a] Disintegrations per minute.

ble lean and fat were then determined by an adaptation of the A.O.A.C. method (1955). The remaining portion of separable lean from each beef round was individually packed in a plastic bag, contained in a cylinder of 11½-in. diameter, and frozen. Gamma-ray measurements were then made of the individual separable lean samples.

RESULTS AND DISCUSSION

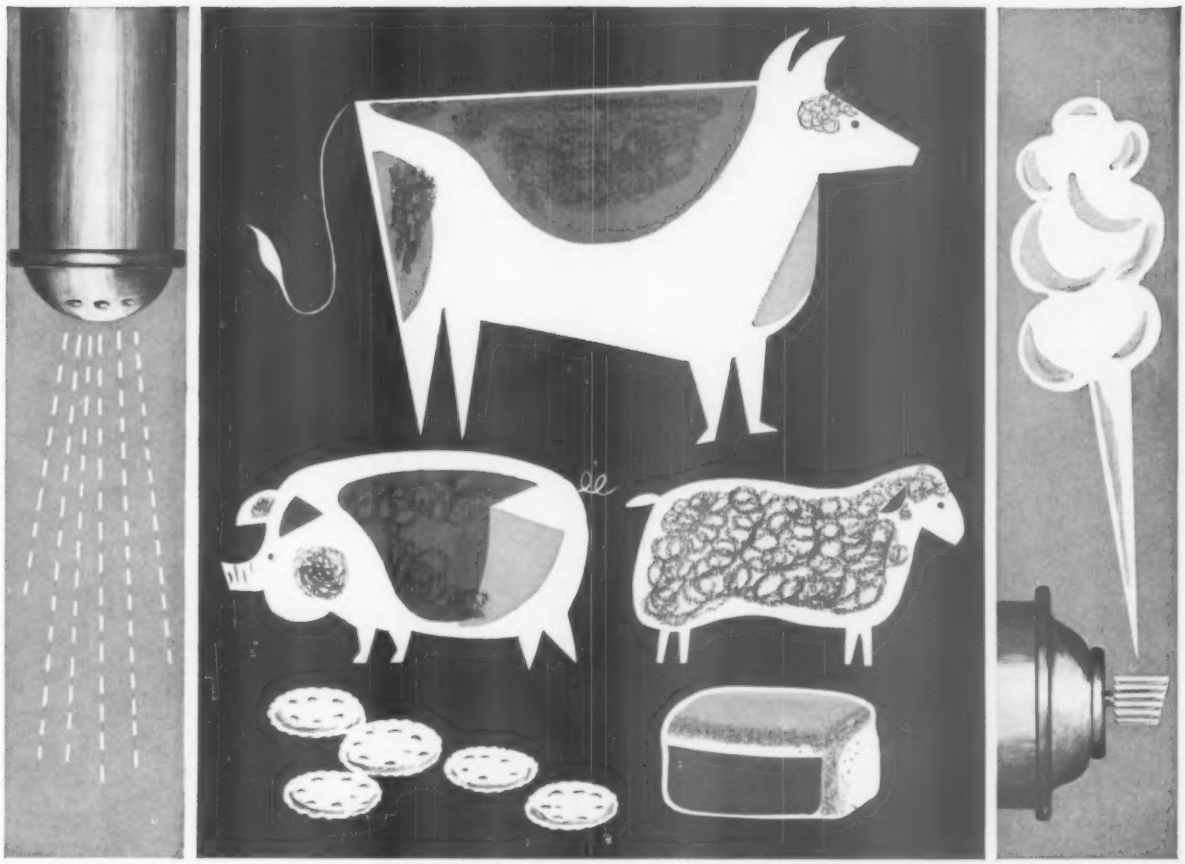
The accuracy with which the lean and fat content of intact meat cuts may be estimated on the basis of potassium-40 measurements is limited by the extent to which the potassium-40 content of the muscle tissue involved varies. The variability of the potassium-40 content of the bone and adipose tissue present also affects a prediction based on the potassium-40 content of a meat cut. In the present study the coefficient of variation for disintegrations per minute from potassium-40 per pound of fat-free separable lean for the 16 bovines was 4.0% (Table 1). The ether-extractable content of the separable lean ranged from 1.7 to 6.4%, averaging 3.4±1.2% (mean ± sample standard deviation). The number of animals involved was small, so that broad conclusions cannot be made, but there was little difference among the mean values for potassium-40 disintegrations per minute per pound of fat-free separable lean for the bulls, steers, and heifers in this study. The coefficient of variation for disintegrations per minute from potassium-40 for the intact rounds per pounds of separable lean present was 4.4%. Since these measurements included the contributions of any potassium-40 that might be present in the separable fat and bone of the intact rounds, somewhat more variability might be expected. Also presented in Table 1 are the values obtained for disintegrations per minute from potassium-40 per pound of intact round, and the percentage composition of these rounds in terms of separable fat, lean, and bone.

The relation between gamma-ray emission and round composition, as well as the relation of weight of the round to its composition, was examined (Table 2). The amount of separable lean in the round was highly correlated with each of the four independent variables examined. However, it was evident from

Table 2. Relation between bovine round weight and separable lean and between various gamma-ray measurements and separable components (16 rounds).

Dependent variable (Y)	Independent variable (X)	Regression equation (Y=)	r[a]	$S_{y.x}$[b]
Separable lean (lb)	Round weight (lb)	0.746X+1.5	0.984	1.18 lb
	K^{40}, dpm[c]/round	0.00307X−1.3	0.982	1.26 lb
	Upper channel net cpm[d]/round	0.0241X−5.0	0.975	1.46 lb
	Cs^{137}, dpm/round	0.00397X+10.2	0.810	3.86 lb
Fat-free separable lean (lb)	K^{40}, dpm/round	0.00295X−1.1	0.983	1.15 lb
Percent separable fat	K^{40}, dpm/lb round	−0.145X+51.5	−.865	1.65%
	Round weight (lb)	0.177X+6.2	0.466	2.91%
Percent separable lean	K^{40}, dpm/lb round	0.141X+40.8	0.798	2.10%
	Round weight (lb)	−0.150X+84.3	−.374	3.23%
Percent separable bone	K^{40}, dpm/lb round	0.00343X+7.7	0.061	1.11%
Percent protein in edible portion	K^{40}, dpm/lb round	0.0307X+11.5	0.689	0.64%
Percent ether extract in edible portion	K^{40}, dpm/lb round	−0.165X+55.8	−0.832	2.17%

[a] 0.623 required for significance at P = 0.01.
[b] Sample standard deviation from regression.
[c] Disintegrations per minute.
[d] Counts per minute.



RHOZYME® ENZYMES OFFER FLEXIBLE ADAPTABILITY AS MEAT TENDERIZERS AND FOOD MODIFIERS

Since RHOZYME proteolytic enzymes are microbiological products, they can be made to a variety of specifications and allow adaptability not afforded by enzymes from plant and animal sources.

For example, RHOZYME P-11 is tailored for optimum effectiveness in meat tenderizing formulations. Rohm & Haas offers basic formulas for both liquid and powder tenderizers. The liquids are ideal for packaging in aerosol spray dispensers. Rohm & Haas has done considerable research to provide good shelf stability to aerosol packaged tenderizers and makes the information available to you. RHOZYME P-11 has been approved by the Meat Inspection Division of USDA for use as a tenderizer in treating meat cuts.

Other RHOZYME proteolytic enzymes are designed for applications such as modifying whey protein for cheese spreads; acting as substitutes for rennet in making cottage cheese; improving quality of bread, crackers, cookies; making protein hydrolyzates for diet foods, cereals, pharmaceuticals.

Write to Dept. SP-16 for enzyme samples, information on aerosol tenderizers, and suggestions for additional uses of proteolytic enzymes in food processing.

ROHM & HAAS

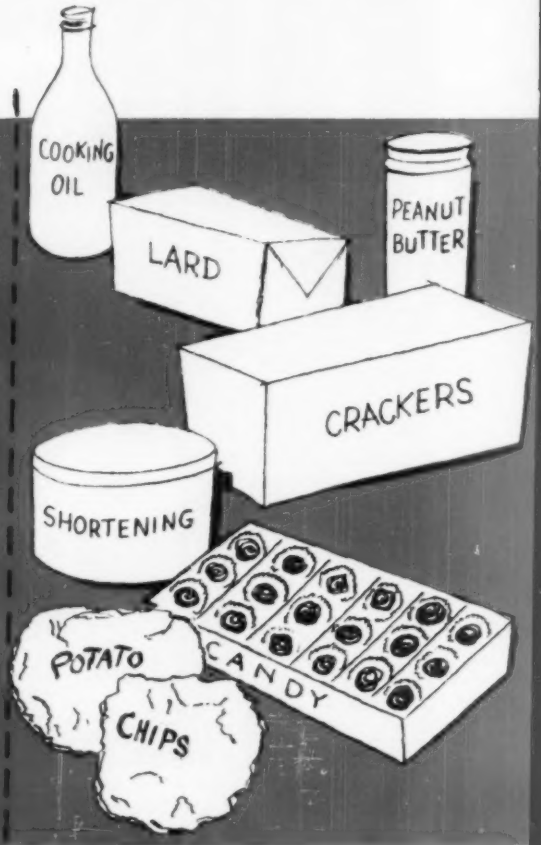
PHILADELPHIA 5, PA.

RHOZYME

412A

Griffith-formulated for particular applications

Highly effective in retarding oxidation for long period in low concentration.	YES—Contains Propyl Gallate
Excellent "carry-through" stability after exposure to high (baking) temperatures	YES—Contains BHT and BHA
Non-toxic	YES
Imparts no flavor, odor, or color	YES
Develops no flavor, odor, or color during its stabilizing life	YES
Doesn't cause metal-reactive discoloration of product	YES—Contains Monoglyceride-Citrate
100% Oil-soluble	YES
Reasonable in cost	YES
Packed in convenient non-returnable drums	YES



G-50 CONTAINS MONOGLYCERIDE CITRATE

Learn all about this exceptional oil soluble antioxidant. Write for descriptive folder.

THE GRIFFITH LABORATORIES, INC.
CHICAGO 9, 1415 W. 37th St.
UNION, N. J.
LOS ANGELES 58

Maximum Oxidative Stability

with

Griffith's® G-50

OIL SOLUBLE ANTIOXIDANT

the standard deviation of cesium-137 emission that it could not provide a useful estimate of lean meat present. There was very little difference between the correlation coefficients ("r" values) for the relationship of round weight to separable lean weight as compared to the relationship of disintegrations per minute from potassium-40 per round to separable lean weight ($r = 0.984$ and $r = 0.982$, respectively). The correlation coefficient for the relation of upper-channel net counts per minute per round to separable lean weight was 0.975. These upper-channel net-count values were not adjusted for the effect of sample weight on counting efficiency or for the cesium-137 contribution to the total count. When separable lean weight was expressed in terms of fat-free separable lean, the relation with potassium-40 was slightly stronger ($r = 0.983$; sample standard deviation from regression, 1.15 lb).

Though the relation between round weight and percent separable fat was not significant, the relation between disintegrations per minute from potassium-40 and percent separable fat was highly significant ($r = -0.865$, sample standard deviation from regression, 1.65%). Kraybill *et al.* (1952) found a highly significant inverse relation between the specific gravity and percent separable fat of ninth-tenth-eleventh-rib cuts from 30 yearling Hereford steers and heifers ($r = -0.911$, standard error of estimate, 2.68%). The correlation coefficient for the relation of potassium-40 emission and round percent separable fat was somewhat smaller in the present study than the value obtained in the beef rib cut study by Kraybill *et al.*, with specific gravity as the independent variable, but the sample standard deviation from regression (standard error of estimate) was considerably smaller in the present study.

The correlation of disintegrations per minute from potassium-40 per pound of round with percent separable lean was highly significant ($r = 0.798$, sample standard deviation from regression, 2.10%). The correlation of round weight with percent separable lean was not significant. The relation between potassium-40 emission and percent separable bone was not significant.

The percent protein in the edible portion of the round (separable lean plus separable fat) was determined by chemical analyses. The correlation of potassium-40 emission with percent protein in the edible portion of the round was highly significant ($r = 0.689$). The sample standard deviation from regression was 0.64%, which is the same value obtained in a study in which beta radioactivity measurements of the ash from samples made up of varying proportions of ham separable lean and fat were related to the percent protein present in the fresh sample (Kulwich *et al.*, 1960a).

The negative correlation between percent ether extract in the edible portion of the round and potassium-40 disintegrations per minute per pound of round was highly significant. The correlation coefficient was −0.832, and the sample standard deviation from regression was 2.17%. A similar standard deviation from regression (2.2%) was found in a study of the relation of beta radioactivity of the ash to the percent ether extract of samples consisting of varying proportions of ham separable lean and fat (Kulwich *et al.*, 1960a). Hankins and Howe (1946) reported a highly significant correlation between percent separable fat as determined by dissection and the ether extract content of the edible portion of ninth-tenth-eleventh-rib cuts from 120 cattle. The correlation coefficient was 0.96, and the standard error of estimate was 2.24%. In the present study, potassium-40 measurements of intact rounds provided an estimate of the ether-extractable content of their edible portion with about the same size of sample standard deviation from regression (standard error of estimate) as observed for the estimation of ether-extractable content in the edible portion of beef rib cuts on the basis of physical separation of the separable fat by Hankins and Howe (1946).

The ranges, means, and standard deviations of the composition data are in Tables 1 and 3. Consideration should be given to the size of the sample standard deviation from regression for the various regressions for estimating the components of round composition (Table 2) in relation to the variability of the component to be estimated (Table 3). These values indicate that rounds differing by only 1–2% in separable fat or separable lean content could not be differentiated on the basis of gamma-ray measurements, whereas some sorting could be done with somewhat larger differences. Further studies with more animals differing in breed, age, and nutritional and management history would be needed to determine the extent to which composition estimates based on gamma-ray estimates might be useful.

Table 3. Ranges, means, and standard deviations of composition data on bovine rounds.

Component	Range	Mean	Standard deviation	Coefficient of variation (%)
Fat-free separable lean (lb)	11.2–36.0	26.0	6.1	23.5
Separable lean (lb)	11.4–36.6	26.9	6.4	23.8
Intact round (lb)	14.1–43.6	34.0	8.4	24.7
Percent protein in edible portion	18.2–21.4	19.8	0.85	4.3
Percent ether extract in edible portion	6.1–17.8	10.9	3.8	34.9

Table 4 summarizes many of the gamma-ray measurements in terms of the estimated potassium contents and cesium-137 gamma-ray emission rates. Variability in the estimated potassium content of the round separable lean was slightly less when values were expressed on a fat-free basis than when expressed as a percent of total separable lean. Blaxter and Rook (1956) studied the potassium content of muscle samples from 8 Ayrshire cattle of both sexes ranging from 1 to 300 weeks old. Although no significant variation of potassium content with age was observed, they found a large variability in the potassium content of muscle samples. Two muscle samples, weighing not more than 500 g, were obtained from each carcass and analyzed chemically. The potassium

Table 4. Summary of data on estimated potassium content and cesium-137 emission of bovine samples based on gamma ray measurements.

Item	Mean ± sample std. dev.	Coefficient of variation (percent)
Percent K in round separable lean	0.365±0.016	4.4
Percent K in round fat-free separable lean	0.375±0.015	4.0
Percent K in composite round separable bone sample	0.183	
Grams K/100 g round separable lean protein	1.70±0.073	4.3
Grams K/100 g water in separable lean	0.494±0.021	4.2
Grams K/100 g separable lean fat-free dry matter	1.59±0.068	4.3
Disintegrations/sec/lb of round from Cs^{137}	2.04±0.40	19.6
Ratio of Cs^{137}/K^{40} gamma rays from rounds	0.45±0.10	22.2

content of muscle in this study averaged 0.398± 0.052% (mean ± sample standard deviation). The coefficient of variation (13.1%) was about three times as large as the coefficient of variation for percent potassium in round separable lean in the present study. It is possible that sampling considerations may account, at least in part, for the much lower variability of estimated muscle potassium content in the present study, since the separable lean sample measured in the gamma-ray detector ranged from 10 to 33 lb whereas Blaxter and Rook used samples weighing not more than 500 g.

The value of 0.183% for estimated potassium content of the composite separable bone sample is about one-half as great as the estimated potassium content of round separable lean. Blaxter and Rook (1956) found no potassium in metacarpal bone from cattle. Van Dilla *et al.* (1961) reported finding only a trace of potassium-40 in pooled cattle bone. Further work is planned at this laboratory to identify the gamma-ray emitters in the separable bone samples. If emitters other than potassium-40 and cesium-137 were present, they contributed to the estimated potassium content in proportion to the counts they contributed to the channel setting used to measure potassium-40 gamma rays. The variability of the potassium content per 100 g of round separable lean protein was about the same as potassium variability in the round separable lean (coefficients of variation, 4.3% vs 4.4%). This was also the case for the variability of potassium per 100 g of separable-lean water content and potassium per 100 g of separable lean fat-free dry matter. The 0.494 mean value for grams of potassium per 100 g of separable-lean water is rather close to the corresponding mean value for potassium muscle water of 0.51 in the study of Blaxter and Rook (1956).

The number of samples in our study was small, and further work is needed to determine the extent to which gamma-ray measurements may be used to estimate the composition of meat cuts. However, the variability of potassium in the fat-free separable lean of the samples in the present study is of such magnitude that some differentiation can be made between samples that vary by more than a few percent in composition.

The ratio of cesium-137 to potassium-40 gamma-ray emission of intact rounds was 0.45±0.10 (mean ± sample standard deviation). This ratio ranged from 0.31 to 0.66 for the 16 rounds. The cesium-137 gamma ray emission rate was 2.04±0.40 (mean ± sample standard deviation) disintegrations per second per pound of round. The values ranged from 1.52 to 3.02 disintegrations per second per pound. Anderson *et al.* (1957) reported a ratio of cesium-137 to potassium-40 gamma-ray emission for beef rounds (spring, 1956) of 0.53, which corresponded to a cesium-137 gamma ray emission rate of 2.04 disintegrations per second per pound of round. These values are well within the range of the values observed for the rounds in the present study, which were obtained from animals slaughtered in the spring of 1960.

ACKNOWLEDGMENT

The technical assistance of M. F. Combs, A. A. Collins, B. E. Denard, and T. Jackson is gratefully acknowledged.

REFERENCES

Anderson, E. C. 1959. Application of natural gamma activity measurements to meat. *Food Research* **24**, 605.

Anderson, E. C., R. L. Schuch, W. R. Fisher, and W. Langham. 1957. Radioactivity of people and foods. *Science* **125**, 1273.

A.O.A.C. 1955. Official Methods of Analysis, 8th ed. Association of Official Agricultural Chemists. Washington, D. C.

Blaxter, K. L., and J. A. F. Rook. 1956. The indirect determination of energy retention in farm animals. I. The development of method. *J. Agr. Sci.* **48**, 194.

Cheek, D. B., and C. D. West. 1955. An appraisal of methods of tissue chloride analysis: the total carcass chloride, exchangeable chloride, potassium and water of the rat. *J. Clin. Invest.* **34**, 1744.

Hankins, O. G., and P. E. Howe. 1946. Estimation of the composition of beef carcasses and cuts. *U. S. Dept. Agr. Tech. Bull.* No. 926.

Kirton, A. H., A. M. Pearson, E. C. Anderson, and R. L. Schuch. 1960. The use of naturally occurring K^{40} to determine the carcass composition of live sheep. *J. Animal Sci.* **19**, 1237. (Abstr).

Kraybill, H. F., H. L. Bitter, and O. G. Hankins. 1952. Body composition of cattle. II. Determination of fat and water content from measurement of body specific gravity. *J. Appl. Physiol.* **4**, 575.

Kulwich, R., L. Feinstein, and C. Golumbic. 1960a. Beta radioactivity of the ash in relation to the composition of ham. *J. Animal Sci.* **19**, 119.

Kulwich, R., L. Feinstein, C. Golumbic, R. L. Hiner, W. R. Seymour, and W. R. Kauffman. 1960b. Relationship of gamma ray measurements to the lean content of hams. *J. Animal Sci.* **19**, 1238 (Abstr).

Pringle, D. H., and R. Kulwich. 1961. K^{40} gammas give estimate of lean meat content. *Nucleonics* **19**, 74.

Snedecor, G. W. 1956. "Statistical Methods," 5th ed. Iowa State College Press, Ames, Iowa.

Swift, C. E., and M. D. Berman. 1959. Factors affecting the water retention of beef. I. Variations in composition and properties among eight muscles. *Food Technol.* **13**, 365.

Van Dilla, M. A., G. R. Farmer, and V. R. Bohman. 1961. Fallout radioactivity in cattle and its effects. *Science* **133**, 1075.

Wetherill, G. W., G. J. Wasserburg, L. T. Aldrich, G. R. Tilton, and R. J. Hayden. 1956. Decay constants of K^{40} as determined by the radiogenic argon content of potassium minerals. *Physiol. Rev.* **103**, 987.

The Maturometer—Instrumental Test and Redesign

(Manuscript received May 10, 1961)

R. S. Mitchell, D. J. Casimir and L. J. Lynch

Division of Food Preservation,
C.S.I.R.O., North Ryde,
New South Wales, Australia

SUMMARY

The aberrant performance of maturometers complying with static tests indicated the need for standard test material for check during instrument operation. Sheet asbestos of 1/16-in. (ca. 1.6-mm) thickness was found to be satisfactory for this purpose and superior to various grades of paper investigated. Excessive friction in diaphragm maturometers was detected by the row test and minimized by adjustment, but a threshold resistance persisted and was measurable by the value of the negative intercept. A laterally stabilized system of ring springs was developed to permit determination of the thrust force along the vertical axis of the sandwich. A maturometer incorporating this system, when submitted to the row test, gave an intercept indistinguishable from zero. This was due to the independent suspension of the pin plate, which, because of the lateral stability, gave precise registration with the sampler plate.

THE ORIGINAL maturometer described by Lynch and Mitchell (1950) is covered by Australian Patent No. 143316. It was established as a suitable means of measuring pea maturity by the high degree of correlation of readings with accepted maturity measures such as alcohol-insoluble solids per cent (AIS), and by the relation of readings to taste-test scores. Further, Lynch and Mitchell (1953) demonstrated that maturometer readings (MR) increased regularly as crops matured, and that the measured maturometer index (MI) of a crop agreed with the weighted mean of the maturometer values of the constituent size grades. For these reasons the maturometer proved useful for quality control and for accurate short-term prediction of the optimal harvest time (OHT) of pea crops.

Fig. 1 shows a device in which the resistance to puncture of peas by pins may be measured. The pins are 1/8-in. (*ca.* 3-mm) diameter and 3/4 in. (*ca.* 19-mm) long, arranged in 13 rows each of 11 pins on 7/16-in. (*ca.* 11-mm) centers. The peas are located in the countersink of holes of 3/16-in. (*ca.* 5-mm) diameter directly below the pins. The lower plate holding the peas (sampler plate) is moved vertically up toward the pin plate, which is attached to a platen sliding on four pillars. The force required for penetration, obtained by measuring the compression of four helical springs mounted concentrically about the pillars, is read from a dial-type depth gauge. The maximum force required for penetration (MR) is indicated by a riding pointer.

Unlike the other instruments in commercial use (tenderometer, texturemeter, and shear press) the maturometer selects the sample size numerically, not by volume. An excess of peas loaded onto the sampler plate is of no consequence, since only those peas in countersinks are penetrated by the pins and contribute to the reading.

The first commercial model was produced in 1951. This instrument differs from the original model by replacement of the helical springs by a diaphragm spring built into the gauge and connected to the pin plate by a rod. Resistance to puncture is determined by measuring the distortion of the diaphragm spring on a gauge calibrated in pounds. A riding pointer indicates maximum force during puncture.

Various minor modifications of this instrument were made between 1951 and 1959. These included an increase in length of the pins to 1 in. (25.4 mm)

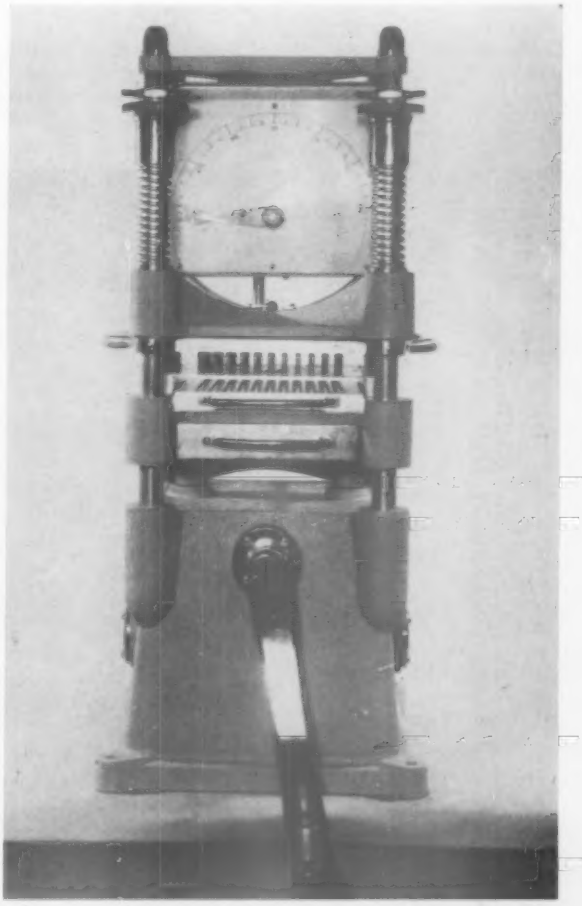


Fig. 1. Original maturometer (1949).

and the use of polytetrafluoroethylene for the pin plate bearings. The latter did not entirely eliminate friction from the measuring system.

During eight years of commercial use the need for further modification became apparent. Friction between the sliding platen and the pillars varied due to misalignment of the pillars and change in surface characteristics. Also, the load of the riding pointer on the indicator needle was not constant and became appreciable due to magnification through the gauge mechanism. Frictional error was finally eliminated by redesign of the measuring system, which, together with testing procedures, forms the subject of this paper.

TESTING OF MATUROMETERS

The efficient performance of an instrument such as the maturometer depends on repeatability of the puncturing force for samples of peas of the same hardness, and transmission of this force to the measuring device with known consistent losses or without loss. Adequate evaluation therefore involves both static and dynamic tests.

The indicating gauge and spring system are readily checked by static methods with the use of weights. The diaphragm gauges were calibrated during manufacture by means of a lever and sliding weight, and subsequent checks of gauges were made by dead weights or by a spring-gauge tester with a check point at MR 250. Coincidence of two gauges could be checked over the whole scale by screwing a gauge on each end of a ½-in. pipe nipple through which a special connecting rod applied a common thrust to both diaphragms.

The apparatus in Fig. 2 was developed to facilitate checking and calibration of the measuring system. The maturometer is suspended so that the pins rest on a rubber-covered steel plate, which is itself supported by an angle-iron framework. A second framework, consisting of two angle-iron bars joined by cross members, is placed on the pillars of the maturometer. Known weights are superimposed, and the gauge reading is checked. A similar method involves platform scales to which the maturometer is applied with varying force by threaded bars and wing nuts. Scale values and MR are compared.

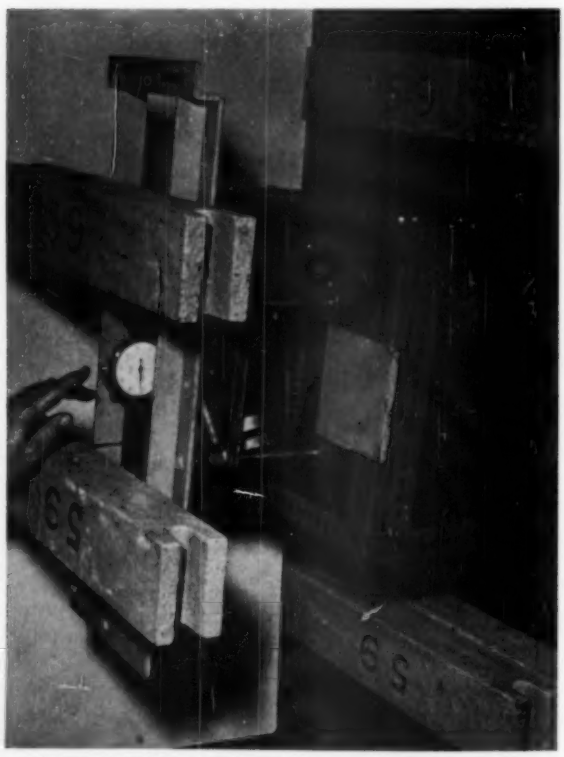


Fig. 2. Static calibration of ring-spring maturometer.

The foregoing static tests do not check the machine in operation, for which purpose peas or suitable test material is required. The relationship between the MR of raw peas and AIS of canned peas was established and may be used as a basis for test. An instrument standardized in this way can be compared with another by making consecutive determinations with each instrument on a well mixed sample of peas. The use of peas for test involves a large number of measurements, and tests are restricted by the availability of fresh material.

Measurements were made on different grades of paper and asbestos sheet to evaluate them as substitute test materials. Blotting paper and asbestos were found to have suitable yield characteristics, but blotting paper showed excessive point-to-point variation within a sheet.

Asbestos 1/16 in. (*ca* 1.6 mm) thick was found to be preferable to thinner or thicker sheets. Pieces of this material punctured by 5 rows of 11 pins (approx 5.2 in. by 2.4 in.; 13.2 cm by 6.1 cm) gave readings of convenient magnitude between 250 and 350.

Uniformity trials of sheets (20 in. by 40 in.; 50.8 cm by 101.6 cm) of asbestos were made with a diaphragm gauge maturometer to determine sampling technique. The sheet was divided into 48 test pieces, and each piece was coded to locate its position. The order of presentation to the maturometer was from left to right and row by row from top to bottom of the sheet. In a second test the order was selected at random.

Statistical analysis of MR of asbestos pieces showed neither observer nor machine effect during the period of test. The between-readings variation was due to differences within the asbestos sheet. A method of comparing two maturometers was devised in which one of each of four pairs of adjacent test pieces is presented to each maturometer. It was established that the means for two sets should agree to within 5 lb for 95% confidence for maturometers of similar performance.

To determine the cause of variation within sheets of asbestos, the effect of the weight of individual pieces and the influence of moisture uptake were investigated. Coded pieces were cut to close dimensional limits, weighed, and tested by maturometer. A highly significant correlation coefficient of $r = +0.75$ (70 degrees of freedom) showed that the maturometer values were influenced by the weights of the asbestos pieces. When allowance is made for weight-maturometer value relationship the experimental error of any test is halved. However, the care necessary in accurate cutting of the pieces and the time required for weighing make this correction of doubtful value.

Relative humidity (RH) was tested as a cause of day-to-day differences between readings on pieces from the same sheet of asbestos. Two series of tests were made on asbestos pieces stored under different humidity conditions in desiccators at 68°F. In the first series, 24 pieces were stored 10 days at each of three levels of RH: 80% RH over sulfuric acid solution, at atmospheric humidity, and over anhydrous calcium chloride. Initial and final weights of the pieces showed a moisture gain of 0.7% of the original weight at 80% RH, and a loss of 0.6% at the low RH. MR increased with decrease in RH, the mean values at the three levels being respectively 340, 398, and 481.

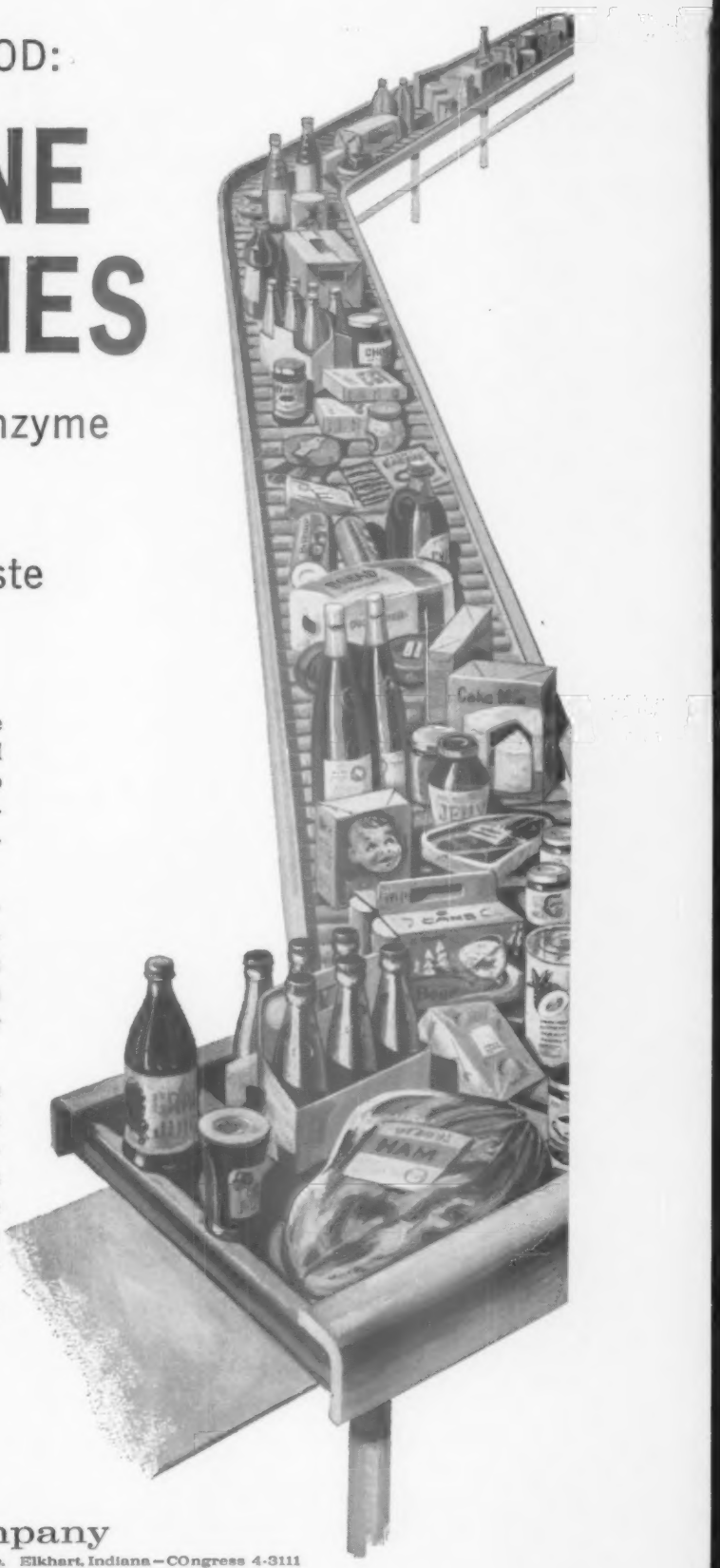
In the second experiment 15 pieces of asbestos were stored two weeks under each of five different humidities. The mean maturometer values were highly significantly different, being 483 over anhydrous calcium chloride, and being 427 for 20% RH, 384 for 40% RH, 364 for 60% RH, and 311 for 80% RH when stored over appropriate concentrations of sulfuric acid. The relation was found to be nonlinear, and correction of readings for RH is therefore not convenient in practice.

Comparison of maturometers at a distance from a standardized maturometer requires a method of storage of standard test pieces of known MR. Asbestos pieces of 4.2 x 2.4 in. stored one month in 307 x 411 cans gave MR 314.8 for the mean of 15 pieces, compared with MR 316.2 for the mean of adjacent pieces tested before the storage period. This showed that as-

Miles has a way with FOOD:

TAKAMINE ENZYMES

...industry's biggest enzyme family made to fit your product's good taste



Exactly what does that mean to you?

A great deal. Producing the biggest enzyme family means that Takamine can recommend the precise *enzymatic activity* best suited to your particular job, whether it's starch conversion, proteolysis, removal of pectins, glucose or oxygen removal, or others.

Refined manufacturing techniques have resulted from this broad experience with enzymes. This means we can achieve the exact enzymatic activity required for specific jobs . . . *and maintain its uniformity*, batch after batch after batch.

So if you now use enzymes to enhance flavor, guard color and stability, lengthen shelf life or speed processing . . . or if you suspect you could use enzymes profitably . . . let us recommend a Takamine enzyme for the job. We don't believe you can find enzymes more precisely matched to your needs anywhere.

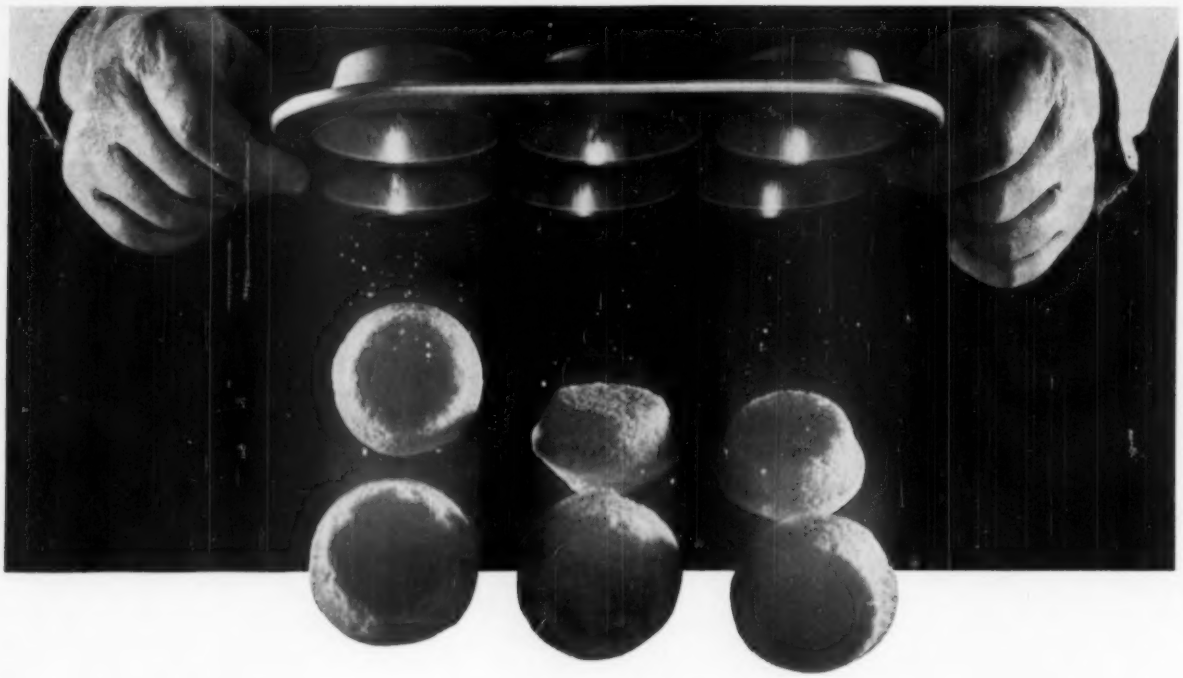
T-2-1

MILES Chemical Company

TAKAMINE®

Division of Miles Laboratories, Inc. Elkhart, Indiana — COngress 4-3111
Clifton, N. J. — PRescott 9-4776 • New York, N.Y. — MUrray Hill 2-7970

416A



this is also a good release agent for hard candy and coated paper—

and it's nutritious, too

The material that lets those muffins fall quickly and cleanly is the same material that gives hard candy superior release from molds and slabs and keeps coated paper from sticking to itself. It is representative of a new class of modified food fats called *Myvacet® Distilled Acetylated Monoglycerides*.

They're nutritious. Some release agents are suitable for use on foods, but *Myvacet Distilled Acetylated Monoglycerides* go the extra mile—they're actually wholesome and nutritious. They're approved* for use, up to 5%, in or on finished food.

They resist oxidation. Some edible release agents soon turn rancid, but *Myvacet Distilled Acetylated Monoglycerides*, tasteless and odorless to begin with, stay that way. They form no rancid odors or gums, outperforming edible oils on oxidative stability every time. And they work. With *Myvacet Distilled Acetylated Monoglycerides*, a hard candy slab can be dressed, a cutting knife lubricated, a meat chute coated by simple brushing, wiping or spraying. No high temperatures are needed to get the release materials ready for use—room temperature is fine.

On metal, glass, or stone, the slight polarity of the Myvacet materials orients them in tenacious films that cling to vertical sides of a tub or trough where other oils won't. Because they are so effective in thin films, transfer to finished food is low. Less material may, therefore, do more work.

To those who are concerned with a search for a material that most closely approaches the ideal release agent, we offer technical bulletins dealing with the properties of the *Myvacet Distilled Acetylated Monoglycerides* best suited for release work. Write for bulletins, and evaluation samples, too. The address is ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies, Inc., West Coast • Charles Albert Smith Limited, Montreal and Toronto.

*U. S. Food & Drug Regulations, Sec. 121.1018

producers of Myvacet®
Distilled Acetylated Monoglycerides

DPi

Also . . . Myverol® Distilled Monoglycerides . . .
vitamin A for foods and pharmaceuticals

Distillation Products Industries *is a division of* **Eastman Kodak Company**

416B

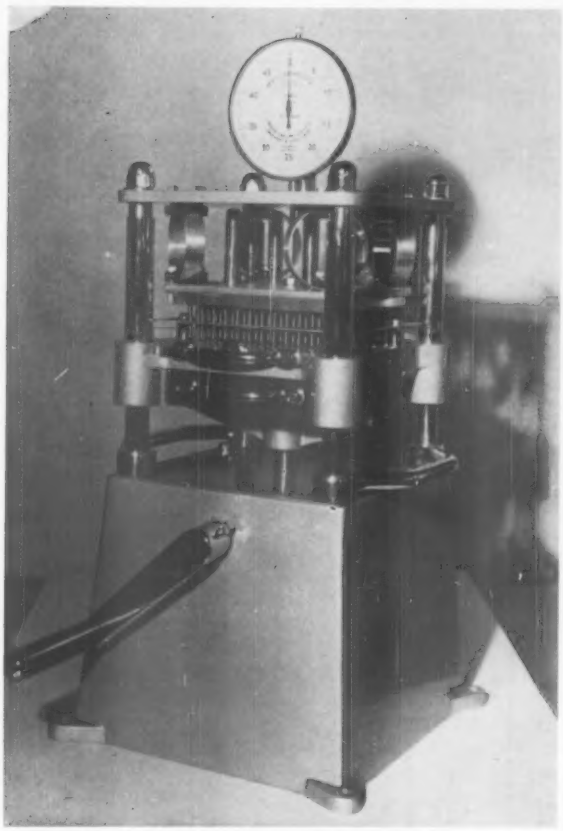


Fig. 3. Ring-spring maturometer.

bestos pieces of known MR could be stored in cans and used in testing maturometers over a period and comparing machines at different locations.

The relation between the number of pins used and MR was investigated by preparing asbestos pieces punctured by 1, 2, 3, 4, and 5 rows of 11 pins. Five sets of such pieces were cut from a sheet of asbestos, and each piece was tested under a diaphragm-type maturometer. Analysis of MR against the rows of pins used showed a very highly significant linear regression ($P < 0.001$):

$$MR = -19.7 + 84.8R$$

where R = number of rows of pins.

Deviations from the regression were found to be nonsignificant. The intercept, −19.7, is highly significantly different from zero, and is interpreted as representing friction in the bearings of the measuring system. This test was varied by use of asbestos pieces capable of puncture by odd numbers of rows containing odd numbers of pins, e.g., 5 x 3 and 13 x 5. This arrangement gave a greater number of points on the graph for number of pins against MR and eliminated uneven loading of the maturometer. The row test constitutes an absolute test, and proves that a well adjusted diaphragm-type maturometer has an irreducible kinematic friction of about 20 lb (9 kg).

A number of diaphragm-gauge maturometers in commercial use for periods up to six years were tested for instrumental error. Both comparative and row tests were used, and adjustments were made as required to obtain satisfactory agreement between machines. It was concluded that the diaphragm maturometer requires constant maintenance for efficient performance, and investigations were started to find a more reliable measuring system. These resulted in the development of the ring-spring maturometer (Fig. 3).

The characteristics of proving rings are discussed by Wilson *et al.* (1946), and simplification and approximation of their equations for deflection and maximum fiber stress across the inner cylindrical area give the following relations, which are satisfactory for practical calculations:

$$\text{Deflection (in.)} = \frac{0.224\ P\ d^3}{Elt^3}$$

Maximum fiber stress across the inner cylindrical elements passing through the load line (lb/sq in.) $= \dfrac{0.954\ P\ d^3}{lt^2}$

where P = load (lb), d = mean diameter (in.), t = wall thickness (in.), l = length of the section (in.), E = Young's modulus (29.5×10^6 lb/sq in.) for steel.

Consequently a ring with an outside diameter of 2.500 in. and a wall thickness of 0.060 in. to compress 0.050 in. for a 62.5-lb diametrical load has a length of 0.638 in.

Maximum fiber stresses across the inner cylindrical elements are calculated as approx. 63,000 lb/sq in. and 126,000 lb/sq in. for respective diametrical loads of 62.5 lb and 125 lb. Wilson *et al.* stated that working stresses as high as 150,000 to 165,000 lb/sq in. have been found satisfactory.

Springs for the maturometer were machined from solid steel bar containing 0.6% carbon and 0.6% chromium, and were heat treated to 45 Rockwell C. They were ground to give 0.001 in. compression for each 1.25-lb (0.567-kg) increment in diametrical load. Measurements showed that the rings returned to their initial diameters after repeated compression by 0.100 in. (2.54 mm).

The deflection of individual ring springs under load was measured on a spring tester (Fig. 4), and sets of four rings in a maturometer were also tested by the dead-weight method (see Fig. 2).

Four calibrated ring springs were clamped to the corners of the pin plate and to the top plate of the maturometer to form a ring-spring sandwich. Compression of the sandwich was measured by a dial micrometer mounted on the top plate with

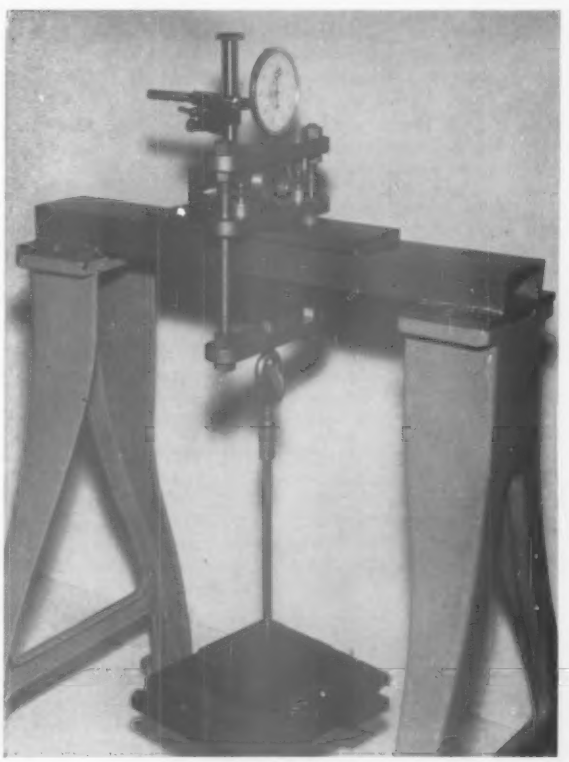


Fig. 4. Ring-spring tester.

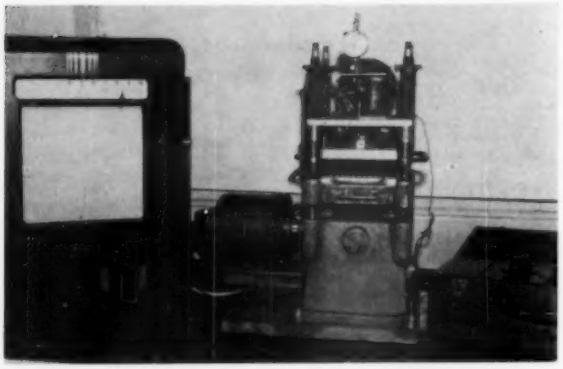


Fig. 5. Mechanized ring-spring recording maturometer.

the gauge rod resting on an anvil attached to the upper surface of the pin plate. Loads from zero to 500 lb (226.8 kg) were applied to the sandwich through the pillars of the maturometer, and the deflection was found to be less than would be expected from single-ring data. When the load was supported directly above the points of attachment of the rings, the gauge reading agreed with that calculated from the performance of individual rings. In general the observed discrepancy was of the order of 0.002 in. (0.05 mm) at 500 lb, which was interpreted as representing the amount of flexure of the top plate. In practice this difficulty was overcome by including the top plate in the measuring system through adjustment of ring dimensions. Alternatively a cast-aluminum plate $\frac{5}{8}$ in. (*ca.* 16 mm) thick with diagonal strengthening ribs was substituted for the original top plate and found to be free of flexure for practical purposes.

The ring-spring sandwich, when assembled in the maturometer, gave correct registration and lateral stability without dependence on guide bearings. The instrument was completed by the addition of a small frictional load on the shaft of the dial micrometer to retain maximum reading and by the installation of safety stops to prevent accidental overcompression.

The ring-spring maturometer was tested with asbestos sheet, and the data were found to fit the regression

$$MR = 6.1\ N + 0.8$$

where N is the number of pins involved in puncture. The intercept + 0.8 is not significantly different from zero, in contrast with the significant negative intercept obtained with the diaphragm maturometer.

In 1957 and 1958, samples of ungraded and size-graded peas were tested by the ring-spring maturometer, and parallel samples were canned. The AIS of the canned peas was determined, and these regression equations, together with that for the original maturometer, are shown in Table 1. They were found to be not significantly different from each other. Thus the ring-spring maturometer gave the same maturity relationship as the original maturometer described by Lynch and Mitchell (1950).

Table 1. Regression equations for maturometer and AIS.

Season	District	Regression equation	Pairs of observations
1947	Bathurst	MR = 33 AIS–153	50
1957	Richmond	MR = 34 AIS–147	28
1958	Devonport	MR = 34 AIS–156	50
1958	Richmond	MR = 34 AIS–154	58

Further modifications of the ring-spring maturometer not yet incorporated into commercial models include mechanization with variable-speed drive to permit the influence of rate of puncture and the recording of force-distance curves during penetration to be obtained. This equipment is shown in Fig. 5. Rates of puncture in the range 0.06 in./sec (*ca* 1.5 mm/sec) to 0.25 in./sec (6.4 mm/sec) did not influence the readings (see Fig. 6).

With young tender peas the force-distance curves show steady increases of force with depth of penetration up to a maximum, which is maintained as shown by the plateau in Fig. 7. Size-graded peas from more mature fractions recorded an intermediate plateau prior to the attainment of maximum reading (Fig. 7).

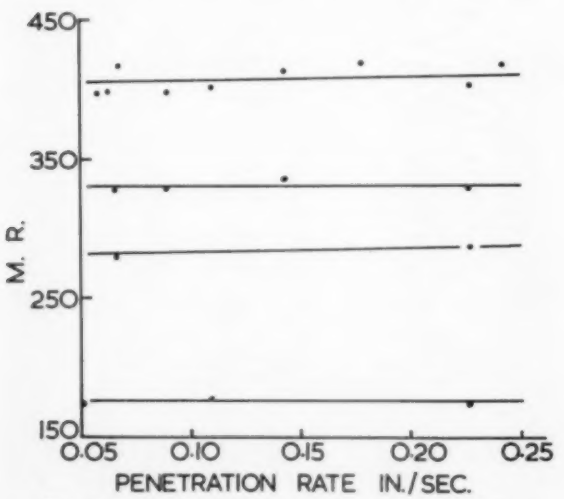


Fig. 6. Speed of operation and maturometer reading.

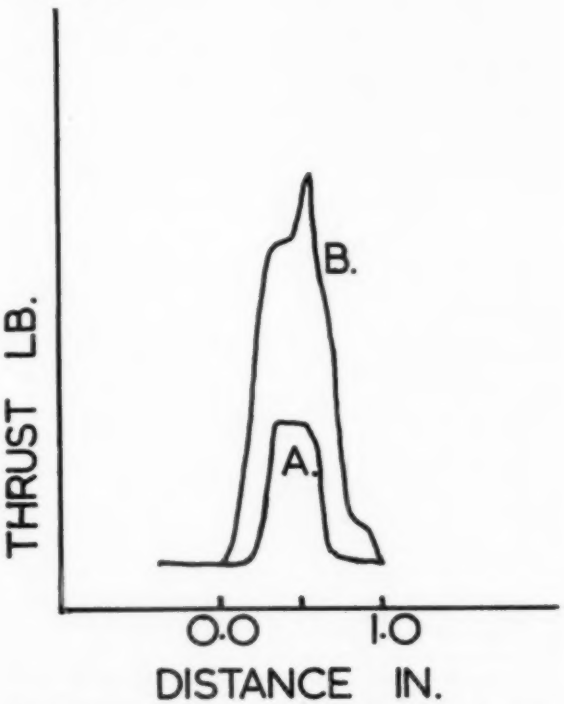


Fig. 7. Force-distance curve of penetration. (A) Young peas; (B) mature peas.

REFERENCES

Lynch, L. J., and R. S. Mitchell. 1950. Physical measurement of quality in canning peas. *Australia, Commonwealth Sci. Ind. Research Organisation Bull. No. 254.*

Lynch, L. J., and R. S. Mitchell. 1953. Optimal harvest time of pea canning crops. *Australia, Commonwealth Sci. Ind. Research Organisation Bull. No. 273.*

Wilson, B. L., D. R. Tate, and G. Borkowski. 1946. Proving rings for calibrating testing machines. *Natl. Bur. Standards (U. S.) Circ. No. C 454.*

Defrost of Prepared Frozen Foods. I.

Defrost Temperatures of Frozen Fruit Pies, Frozen Meat Pies, and Frozen Soups

(Manuscript received March 8, 1961)

M. J. Fanelli and M. F. Gunderson

Bacteriological Research Department,
Campbell Soup Company, Camden, N.J.

SUMMARY

The defrost temperatures of several prepared frozen foods were determined. Defrost temperatures ranged from 15.2 to 29.5°F. The time necessary for case lots of the products to become defrosted ranged from 2.25 to 32.5 hr. The shape of time-temperature curves for all products was similar. Studies indicated that any degree of defrost had an adverse effect on the quality of the frozen products.

TEMPERATURES that cause frozen products to defrost may occur during storage, transport, and marketing of frozen foods. Changes in the products vary greatly with the length of time the product is held in the defrosted state, the refreezing procedure used, the temperature the defrosted product attains, the bacteriological flora present initially, the type of product, etc. Before the effect of any variations in the conditions causing defrost of frozen product can be assessed, the characteristics by which a defrosted product can be recognized either in the defrosted or the refrozen state must be established, and a simple objective measure of defrost must be obtained. One objective measure of defrost is the temperature at which defrost occurs.

Although the physical constants of many non-food products are well known, there are few reports on the defrost of frozen foods. Woolrich (1933), in investigations of the thermal properties of fruits, meats, vegetables, and sugar solutions, reported that the latent heat of fusion of the foods tested was directly proportional to the moisture content by weight, and that, although fats, starches, and sugars did not affect the value of the latent heat of fusion of the foods tested, the fusion points of foods were considerably depressed by starches, fats, sugars, and alcohol. He found that most foods have a freezing and thawing range of several degrees, extending from just below 32°F to near 0°F.

Short and Bartlett (1944) calculated the enthalpy changes of food products from extensive experimental data and from mathematical and thermodynamic calculations. Riedel (1951), working on fruit and vegetable juices, concluded that only the liquid portion of the juice undergoes change of state and he derived a method of calculating enthalpies from the solid content of the foods. Mannheim *et al.* (1955) found that freezing and thawing were essentially the same from an energy standpoint and that the enthalpy of a food product could be calculated if the exact moisture content of the specific food was known and allowances made for the unfrozen portion of water, and if the average temperature of the product before and after freezing and thawing was known.

In a discussion of several methods of determining product temperature within cases, Guadagni and Jansen (1957) gave temperature curves for the defrost and refreezing of orange juice which indicated that a change of state had occurred. Their data indicated that the defrost temperature of the food could be readily determined by following the temperature changes in products that were subjected to storage temperatures above 32°F. The experiments reported here were made to determine the temperature at which several commercially prepared frozen foods became defrosted, to study the time-temperature relationships of the defrosting product, and to establish some of the organoleptic criteria by which a defrosted product could be recognized.

EXPERIMENTAL

Cases of commercially prepared frozen products were obtained from the production line or from the commercial blast freezers and stored at −13°F until ready for use. For experimental purposes, the cases were removed from storage and placed in a refrigerating incubator controlled at 50±2°F. Three different types of cases were used: one for 5-oz fruit pies, one for 8-oz meat pies, and one for 10½-oz soup cans (Fig. 1).

Temperature changes within the products were followed by placing copper-constantan thermocouples in the geometric center of the products since preliminary tests had established that this position was the slowest-heating section of the product. Two types of thermocouples were used. A specially designed needle-type metal thermocouple with a detachable head was inserted into the frozen meat and fruit pies. An insertion-type Bakelite thermocouple was used for the soups. The soup cans were filled and frozen with the thermocouples in place. All thermocouples were connected to a multiple-point recording potentiometer. Thermocouples were placed in the incubator to determine the ambient temperature immediately surrounding the case of product.

Preliminary tests were run to determine the approximate temperature of defrost. In actual experiments, the temperature changes were followed closely from 5°F below the approximate defrost temperature to 5°F above the defrost temperature. Visible changes in the products were followed during the holding periods to determine the changes characteristic of a defrosted product.

Samples of the pies were taken after various holding times for use in organoleptic evaluation. These pies were refrozen in a blast tunnel, stored at −13°F, then removed and baked according to the directions given by the producers. The defrosted products were compared with products from the same lot that had been held in the frozen state at −13°F.

Fifteen different products were examined:

Dessert pies	*Meat pot pies*	*Soups*
Apple	Chicken	Clam chowder (New
Blueberry	Beef	England style)
Cherry	Tuna	Potato (cream type)
Custard	Turkey	Vegetable beef
Mince		
Peach		
Pumpkin		

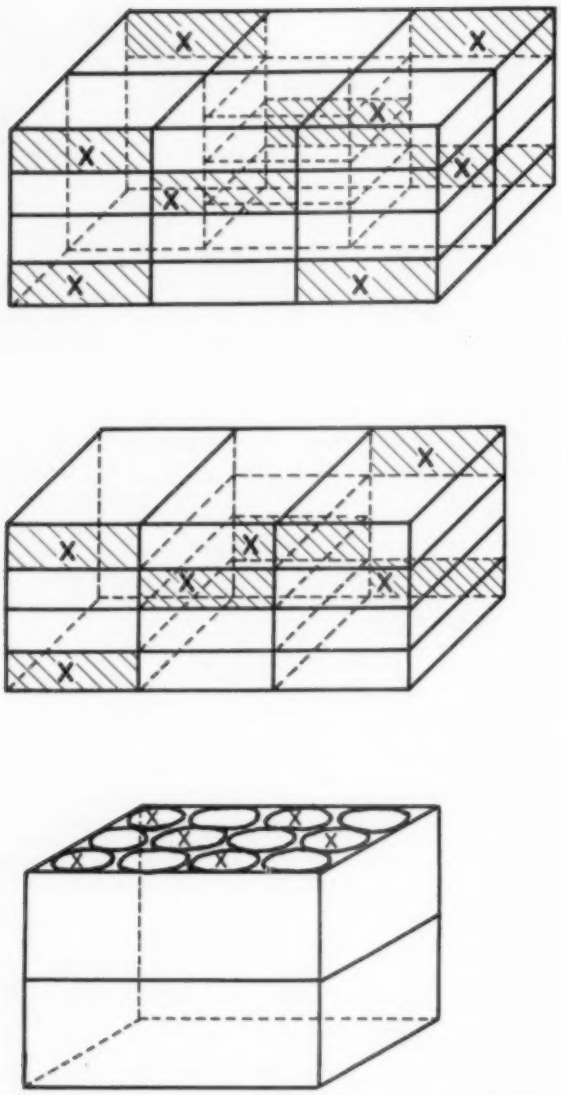


Fig. 1. Stacking plan for storage of frozen product at 50°F. Thermocouples are indicated by shaded areas marked with an X. Top, meat pies; middle, fruit pies; bottom, soups.

At least six different cases of product were examined. Thermocouples were placed in six locations in each case (Fig. 1). Defrost temperature was calculated for each of the products from every complete temperature record. Results were averaged to obtain the reported defrost temperature.

RESULTS AND DISCUSSION

As a substance changes state from a solid to a liquid, a specific amount of heat must be absorbed by the substance to effect the change of state. This heat is called the heat of fusion. During the time the substance is changing state, the temperature of the product remains constant. In these experiments, the temperature at which the change of state took place was determined by following the temperature changes in a product stored above freezing. Preliminary experiments had shown that the change of state was too rapid to allow accurate determinations at 70°F; at 35°F, the reaction was too slow; 50°F was chosen as the most convenient working temperature.

The fifteen different products tested were classified into three groups: dessert pies, meat pot pies, and soups. In general, all of the products had the same type of defrost curve. The rates and temperatures of defrost varied. In Fig. 2 the average defrost rates

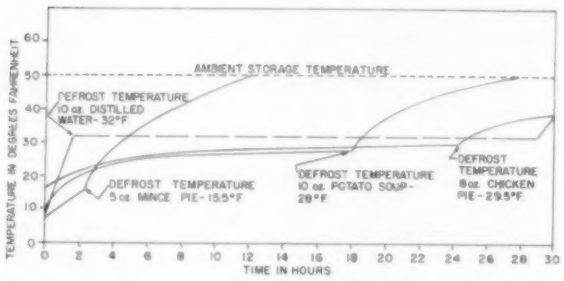

TEMPERATURE IN DEGREES FAHRENHEIT
TIME IN HOURS
AMBIENT STORAGE TEMPERATURE
DEFROST TEMPERATURE 10 oz. DISTILLED WATER - 32°F
DEFROST TEMPERATURE 5 oz. MINCE PIE - 15.5°F
DEFROST TEMPERATURE 10 oz. POTATO SOUP - 29°F
DEFROST TEMPERATURE 8 oz. CHICKEN PIE - 29.5°F

Fig. 2. Average defrost rate and temperature of case lots of frozen foods held at 50°F compared to water under similar conditions.

and temperatures of case lots of prepared foods held at 50°F are compared to those of water under similar conditions. These are typical defrost curves. The curve given is for the sample of each product that had the most rapid defrost rate. This was always one of the outer layers of product in the case, usually one of the samples in the top layer rather than the bottom layer. Curves for product that defrosted less rapidly were similar; the rate was slower. As the temperature of the frozen product approached the temperature of defrost, more heat was needed to effect the change of state. This is reflected in the appearance of an inflection point in the curve. As the product passed through the defrost temperature, the rate of change of temperature was accelerated until the temperature of the product approached the temperature of storage.

Table 1 shows the temperature of defrost of all of the frozen products tested. All of the temperatures of defrost were below 30°F. The fruit pies consistently had lower defrost temperatures than did the meat pies. This is to be expected since the fruit pies contain concentrated sugar solutions, which tend to depress the freezing point more than do the soluble solids in the meat pies.

As can be seen in Table 1, the defrost temperature of mince pie was about 10°F below that of the other fruit pies. Preliminary tests with some mince pies removed from storage at −13°F and allowed to stand 15 min before being used indicated that the initial temperature of the pies, 12°F, was very close to the defrost temperature of mince pie. The temperature of these pies rose rapidly to the ambient temperature (Fig. 3). For experimental purposes, the cases of

A symbol for a perfect pack...

DIAMOND CRYSTAL FLAKE-TYPE SALTS

- Uniformly 99.95% Pure
- Uniform in the size and grain you need—EVERY TIME

Diamond Crystal Flake-type Salts, made by the exclusive Alberger process, assures a flake-like crystal of extremely high purity. Precision screening provides a wide range of sizes to meet all requirements. This high purity and controlled size represents a MEASURABLE MARGIN OF SUPERIORITY over ordinary granular-type salts.

Diamond Crystal Flake-type Salts contain less than 20 parts per million insolubles. Filter pad tests consistently indicate that it has the lowest content of insoluble matter or foreign material of *any* canning salt. The low content of injurious compounds (calcium, magnesium) and trace metals provides the required purity that permits still further up-grading of your product. The unmatched cleanliness of this salt avoids reaction with oxalates and formation of white precipitate. Because of this, Diamond Crystal Flake-type Salts bring out the natural flavor of your product.

Learn exactly how these product features can benefit you. Call or write the nearest Diamond Crystal sales office.

Diamond Crystal Salt Company

ST. CLAIR, MICHIGAN

PLANTS: AKRON, OHIO; JEFFERSON ISLAND, LA.; ST. CLAIR, MICH.
SALES OFFICES: AKRON • ATLANTA • BOSTON • CHARLOTTE • CHICAGO
DETROIT • LOUISVILLE • MINNEAPOLIS • NEW ORLEANS • NEW YORK

GOOD THINGS TO EAT

always taste better made with

Food Materials custom flavors

FOOD MATERIALS CORPORATION / 2711 W. Irving Park Rd., Chicago 18 • 254 W. 31st St., New York 1

Table 1. Time and temperature of defrost of single cases of frozen product held at 50°F.

Product	Average defrost temperature[a] (°F)	Average initial temperature[a] (°F)	Average defrost time[b] (hours)	
			Outer layers	Inner layers
Dessert pies (5 oz)				
Mince	15.2	5	2.25	4.0
Cherry	24.5	16	4.2	6.3
Pumpkin	25.7	14	8.2	12.3
Peach	25.8	13	6.8	11.3
Blueberry	26.5	19	4.6	7.9
Apple	26.6	17	6.8	11.8
Custard	27.5	16	11.9	19.0
Meat pies (8 oz)				
Beef	28.5	17	16.4	32.5
Tuna	28.8	13	16.2	27.7
Turkey	29.5	18	15.6	31.0
Chicken	29.5	17	16.0	31.5
Soups (10½ oz)				
Clam chowder (New England style)	24.0	5	.....	20.0
Potato (cream type)	28.0	7	.....	18.0
Vegetable beef	28.0	7	.....	13.0
Water (10½ oz)	32.0	8	.....	28.5

[a] Average of 36 determinations.

[b] Average of 6 determinations.

mince pies were placed in a wind tunnel at −30°F for several hours before being used. This reduced the initial temperature to 5°F, and allowed the rate of defrost to be determined (Fig. 2). The defrost curve then appeared similar in shape to that of the other products.

Another fact was brought out in the determination of the defrost rate of mince pies. Tests indicated that a second inflection point in the defrost curve appeared at 26°F (Fig. 4). This point did not always occur, but appeared frequently enough to indicate a need for further investigation. It had been noted in preliminary experiments that when the interior of the mince filling was near defrost temperature, the pie crust was determined to be 26°F. In pies whose filling defrosted at about 26°F, the defrost of the crust occurred simultaneously. This emphasized the

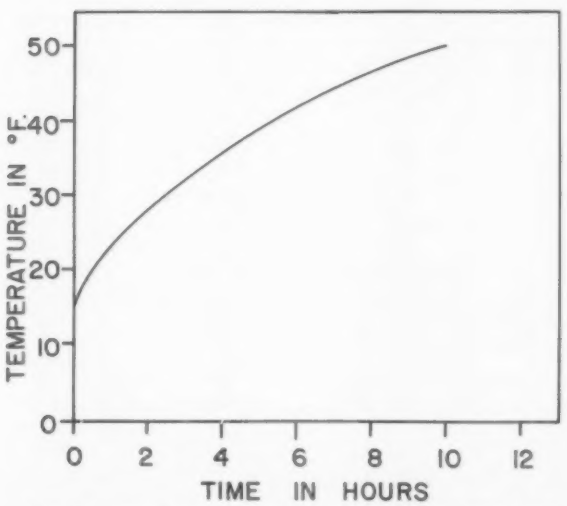


Fig. 3. Defrost rate of case lots of mince pies; initial temperature 14°F.

defrost temperature of the filling by prolonging the time of defrost. When the filling defrosted at a much lower temperature, the defrost of the crust was reflected by the inflection point on the defrost curve.

Actual defrost temperature can influence the effectiveness of storage temperature of a product. In studies by many workers (Gortner *et al.*, 1948; Hucker *et al.*, 1952; Winter *et al.*, 1952) on the effect of fluctuating storage temperatures below 32°F on the quality of frozen foods, the fluctuating temperatures may have occurred in the range of the actual defrost temperature of the product. This would mean that the product being tested was actually being partially defrosted and refrozen during the temperature fluctuation. This change of state, with its resultant change in cell tissues, enzyme systems, and microbial flora, could explain the deterioration of the organoleptic quality of the product.

Several workers (Hartsell, 1959; Hucker *et al.*, 1952) have noted that there is a greater reduction in the number of bacterial cells in products held at tem-

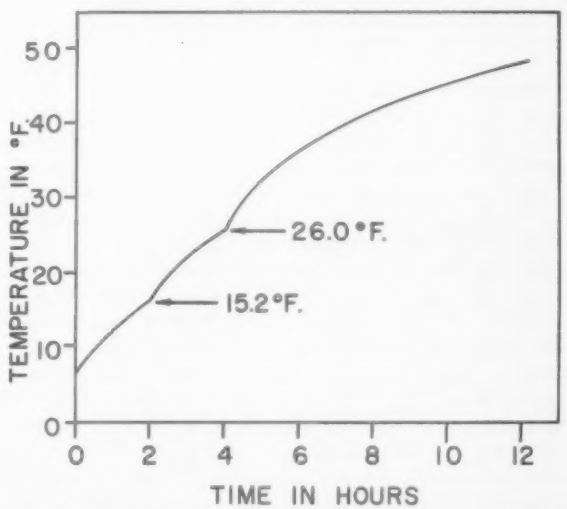


Fig. 4. Defrost rate of case lots of mince pies; initial temperature 5°F.

peratures between 28°F and 14°F than between 5°F and −4°F. Since the higher temperature range may include the actual defrost temperature of the product, the reduction in the numbers of organisms could have been caused by thawing and refreezing.

The effect of defrost was very noticeable on the organoleptic quality of both the pies that had been defrosted and refrozen and the pies that had been defrosted, refrozen, and baked. Fig. 5 shows the appearance of chicken pot pies defrosted at various temperatures, refrozen, and baked. The control pie (C) is from the same lot as the other pies. Pies brought to defrost temperature and immediately refrozen and then baked showed crust damage. The top crust was shiny and greasy, and had a tendency to appear layered or flaked. Fig. 6 illustrates the appear-

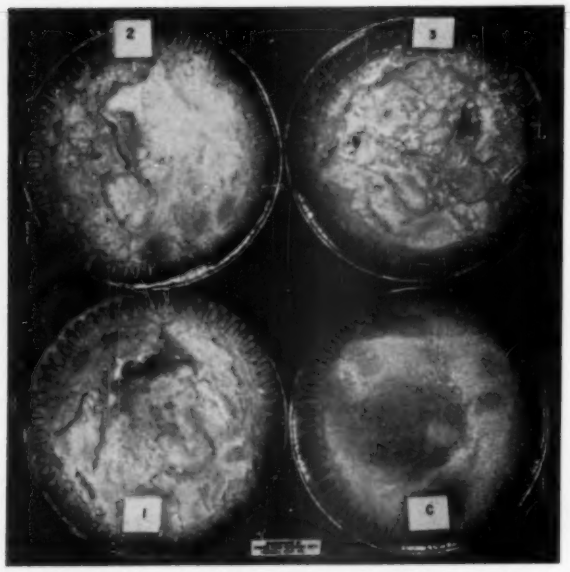


Fig. 5. Exterior view of chicken pot pies defrosted at various temperatures, refrozen, and baked: 1) defrosted at 35°F; 2) defrosted at 40°F; 3) defrosted at 50°F; C) control.

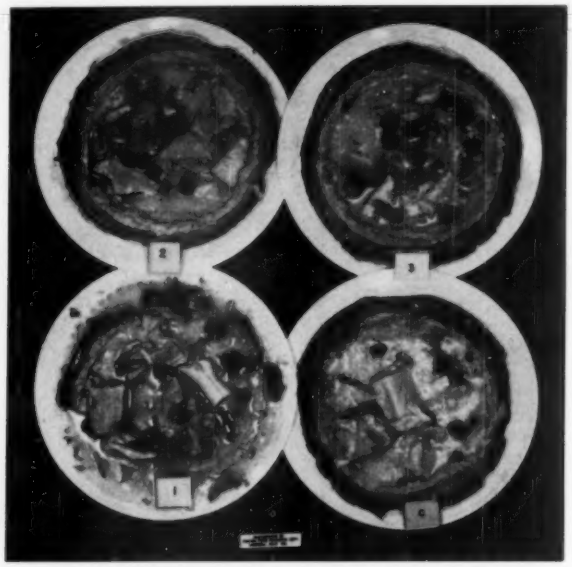


Fig. 6. Interior view of chicken pot pies defrosted at various temperatures, refrozen, and baked: 1) defrosted at 35°F; 2) defrosted at 40°F; 3) defrosted at 50°F; C) control.

ance of the filling of these pies. Pies brought to 50°F (No. 3 in both figures) before being refrozen and baked showed extensive crust damage. The bottom crust frequently was soggy and soaked with filling. Damage to fruit pies was especially noted in the crust. In almost all cases of defrosted fruit pies that had been baked, the bottom crust was stuck to the pie plate and the top crust was stained with filling. In some cases, thinning of the filling was extensive.

These studies indicate that *defrost of any degree adversely affects the quality of frozen foods.* This loss in quality can be attributed to physical and chemical changes occurring at or around the defrost temperature of the product and will occur even in the presence of low numbers of microorganisms whose enzyme systems are active at low temperatures. Unless product is held continuously in the frozen state, changes in quality occur that cannot be reversed and possibly are not even halted by refreezing.

REFERENCES

Gortner, W. A., F. Fenton, F. E. Volz, and E. Geim. 1948. Effect of fluctuating storage temperature on quality of frozen foods. *Ind. Eng. Chem.* **40**, 1423.

Guadagni, D. G., and E. F. Jansen. 1957. Gaging frozen food temperature. *Food Eng.* **29** (7), 74.

Hartsell, S. E. 1959. The testing of frozen eggs for pathogens. *J. Milk Food Technol.* **12**, 107.

Hucker, G. J., R. F. Brooks, and A. J. Emery. 1952. The source of bacteria in processing and their significance in frozen vegetables. *Food Technol.* **6**, 147.

Mannheim, H. C., M. P. Steinberg, and A. I. Nelson. 1955. Determination of enthalpies involved in food freezing. *Food Technol.* **9**, 556.

Riedel, L. 1951. The refrigeration effect required to freeze fruits and vegetables. *Refrig. Eng.* **59** (7), 670.

Short, B. E., and L. H. Bartlett. 1944. The specific heat of foodstuffs. *Univ. Texas Publ.* Bull. 4432.

Winter, J. D., A. Hustrulid, I. Noble, and E. S. Ross. 1952. The effect of fluctuating storage temperature on the quality of stored frozen foods. *Food Technol.* **8**, 311.

Woolrich, W. R. 1933. The latent heat of foodstuffs. *Tenn. Univ. Eng. Expt. Sta.* Bull. 11.

Some Observations on the Continuous Process of Breadmaking[a]

(Manuscript received June 16, 1961)

R. A. Bottomley

M.B.T. Research Laboratory Pty. Limited (a subsidiary of Mauri Brothers & Thomson Limited) Sydney, Australia

SUMMARY

A preferment containing all ingredients except flour, major oxidizing agents, and shortening constitutes an essential part of the continuous system of breadmaking, which is briefly described. In a standard sucrose preferment the sugar utilization, alcohol, carbon dioxide, acidity, etc., changes are shown to be essentially those of an anaerobic, alcoholic fermentation. Yeast growth was measured by cell counts and by measuring major and minor axes after photographing representative fields and subjecting the results to statistical treatment. Hightly significant increases were noted, and cell budding increased from 1.5% to 9.5%. The addition of thiamin, riboflavin, and niacin in amounts sufficient to ensure that the resultant bread complied with U.S.A. standards for enriched bread, stimulated yeast growth and fermentation changes. The addition of sodium diacetate, a "rope" and mold inhibitor, increased the acidity and slightly depressed yeast activity. No increase in the number of budding cells was noted. Substituting maltose in the form of non-diastatic malt extract for sucrose (on an equivalent cost basis) in the presence of sodium diacetate slowed fermentation markedly, though this was not reflected in the experimental bread, which, however, had a different flavor. It is possible that limitations of the apparatus used to produce the dough could obscure differences due to preferment components. It is suggested that a preferment time of less than the 2½ hours used commercially could be beneficial.

FOUR YEARS AGO, it was stated that "The bakery of the future is a matter for conjecture, but I should be surprised if the days of the baker as we know him now, are not numbered. I expect to see the time when a large bakery will be operated under the control of a food technologist, with a production staff consisting of a storekeeper, materials handler, mixer, electricians, refrigeration mechanic and three other mechanics. Naturally the normal distribution staff will be required . . . " (Bottomley, 1956).

However, one must confess to some astonishment at the rate at which the baking industry is moving toward this state of affairs. In fact, apart from overestimating the number of mechanics required, the situation forecast is already well-established in the U.S.A., Canada, England, and Australia.

This change is due to the ready acceptance of the continuous process of breakmaking invented by Dr. J. C. Baker and developed by him and his colleagues in the Baker Process Co., a Division of Wallace & Tiernan Inc.

[a] A paper given to the Royal Australian Chemical Institute, Cereal Chemistry Group, Tenth Annual Conference, held at Leura, N.S.W., October, 1960.

The first commercial unit was installed in the U.S.A. at the end of 1953 and was operating in early 1954. The second was working in mid-1955. These served as the final check on the developmental work and operating techniques. Subsequent industrial demand was rapid.

Today, some 90 units are operating in the U.S.A. and new units are being produced at the rate of two per month. The features of this continuous system of manufacture, which we have studied in the U.S.A., England, and Australia, are as follows:

All the bread ingredients except the flour, fat (shortening), and major oxidizing agents are combined with stirring in a stainless-steel tank, where they ferment for a prescribed period of time, about 2½ hours, at 85–89°F.

Since a tank generally holds enough of the preferment (100 gal.) for 30 min of bread production, five tanks are required, each being "set" at half-hourly intervals. At the end of the fermentation time the contents are transferred to a holding tank, which feeds a small constant-level tank. From this, the liquor is pumped, at an automatically controlled rate, through a heat exchanger to a premixer, the oxidizing solution being added just before entry. The flour enters the premixer via a conical bin equipped with vibrators situated above a gravimetric Merchen scale-feeder and a vibrating sifter, thus ensuring a completely even flow. The melted fat (shortening) at approx 140°F, enters the premixer through a proportioning pump. It takes not more than one minute to ensure complete mixing, after which the dough is pumped to the "developer-divider." This consists of a pair of variable-speed counter-rotating impellers in an oval-shaped bowl. The dough is kneaded for about one minute to a pre-set viscosity, when it is extruded through a divider of great accuracy. The dough pieces fall into the bread tins (pans), which pass underneath on a moving belt at a rate synchronized with operation of the divider.

All operations are controlled from a centrally located panel. The output may be varied from 42 to 100 lb of dough per minute in units of up to 2 lb. The weight of the dough pieces can be varied in about 30 sec.

Quite apart from many other advantages the unit saves space, materials and labor, but it is not our purpose here to discuss its economic merits but rather to examine the fermentation and its effects.

Fuller descriptions of the continuous process may be found in papers published by Lawler and Ziemba (1956), the staff of "Food Engineering" (1956), the

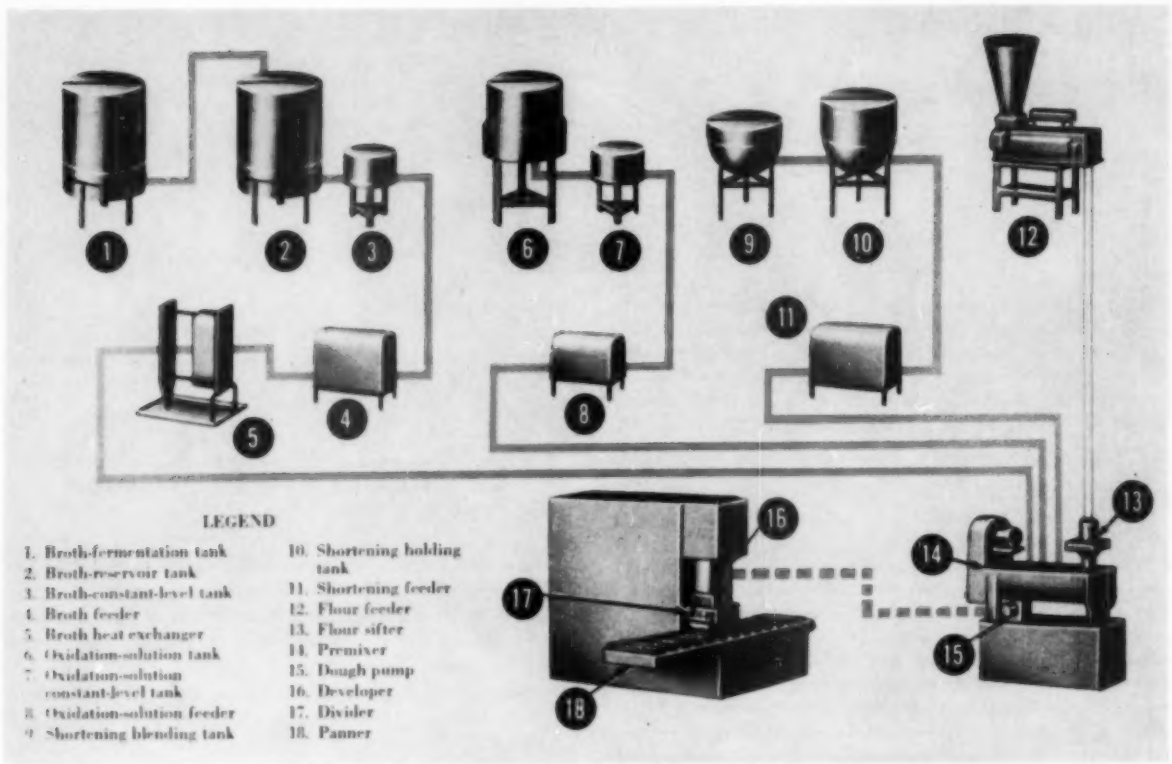


Fig. 1. Flow diagram, "Do-Maker" continuous dough-making process.

staff of the Baker Process Co. (1960), and Milgate (1960). A schematic flow sheet is shown in Fig. 1.

It should be noted that in this process the maximum time that the flour is subjected to fermentation changes is 63 minutes. In the conventional process, allowing the short bulk fermentation time of 2 hr, which is about the shortest employed, the maximum time is 205 minutes. The least time that flour is fermented in the production of conventional bread is where the Strahmann mixer is used, when it amounts to 100 minutes. The time distribution for various operations, together with the yeast quantities employed, is shown in Table 1.

The term "make-up," as used in the table, covers dividing, rounding, intermediate proof, and molding where employed.

Consideration of the flour fermentation times suggests that considerable differences in biochemical reactions are likely, with consequent differences in the characteristics of the bread.

The reactions of the conventional system, where the yeast initially ferments the nonreducing carbohydrates of the flour and then ferments the maltose produced by enzyme action, gluten simultaneously undergoing beneficial physical changes, are well-known.

However, in the Do-Maker process, which is a two-stage system, most of the fermentation occurs apart from the flour. Further, the dough, when made, has a water content higher than usual and is less viscous and much stickier than conventional doughs. In fact, it is impossible to handle this dough. The differences in the formulae are shown in Table 2.

Table 1. Comparison of flour fermentation times and yeast quantities in different breadmaking procedures.

Operation	Time (min)		
	Do-maker process	Conventional	Strahmann
Mixing	1	15	0.7
Bulk fermentation	0	120[a]	50
"Make-up"	2	15	12
Tin-proof	45	40	23
Time in oven to cessation of enzyme actions	15	15	15
Total	63	205	100.7
Yeast (% of flour)	3.0	2.0	2.5

[a] The shortest time used in current commercial practice.

EXPERIMENTAL

Previous workers, for example Miller and Johnson (1958), have compared preferments buffered with different ingredients such as flour, dry milk, and salt. In this study we have measured changes occurring during a fermentation made according to a standard commercial formula together with three variations. The formulae are listed in Table 3. Apart from formula 4, where maltose (as non-diastatic malt extract) replaced sucrose on an equivalent-cost basis, the modifications were only slight. Formula 2 differed from the standard only in the addition of vitamins sufficient to ensure that the resultant bread would comply with the U.S.A. standards for enriched bread, and formula 3 differed only in the addition of "sodium diacetate," a loose equimolecular compound of acetic acid and sodium acetate used for the inhibition of "rope" (Bacillus subtilis infection) and mold in bread. This inhibitor was used in formula 4 also.

Table 2. Australian formulae for Do-Maker and conventional (straight-dough) breads (expressed as percentage of flour weight).

Ingredients	Do-Maker		Conventional Dough stage	
	Brew stage (%)		Standard (%)	Milk-loaf (%)
Water	70.0		56–60	56–60
Non-fat dry milk	4.0		....	4.0
Sugar	4.0		....	2.0
Salt	2.0		2.0	2.0
Malt extract (N.D.)[a]	0.5		....	....
Improver	0.5		0.5	0.5
Compressed yeast	3.0		2.0	2.0
		84.0		
	Dough stage			
Flour	100.0		100.0	100.0
Fat	3.0		....	2.0
(Plus oxidizing agent)		103.0	....	....
Total:		187.0	160.5 to 164.5	168.5 to 172.5
Flour in dough (%)		53.5	62.5 to 61.0	60.0 to 58.5

[a] Non-diastatic malt extract, 56.0% anhydrous maltose.

Doughs were produced from the preferments by a high-pressure mixing technique, described later, and baking was carried out in a rotary-hearth oven. Although the resultant bread resembled that from the commercial Do-Maker plant, the operation was not considered sufficiently sensitive to measure physical differences, if any, due to alterations in the preferment formulae. However, flavor differences were noted.

In the preferments the rate of change of pH, titratable acidity, alcohol, reducing sugars, carbon dioxide, fermentative capacity, and yeast growth have been measured.

ANALYTICAL METHODS

The pH was measured with a glass electrode and a Pye direct-reading Universal Laboratory Model pH Meter.

Titratable acidity was determined by the amount of 0.1*N* sodium hydroxide required to bring the preferment to a pH of 5.5.

Alcohol was determined by distilling from a 5-ml sample into 10 ml potassium dichromate (42.608 g/L) plus 20 ml conc. sulphuric acid and back-titrating the excess dichromate with ferrous ammonium sulphate (92 g/L) using phenyl anthranilic acid as indicator.

Reducing sugars were determined by the method of Bates *et al.* (1942). Carbon dioxide was determined by mixing under vacuum 10 ml of preferment with 10 ml 1*N* hydrochloric acid and 100 ml freshly distilled carbon dioxide-free water and then distilling the carbon dioxide under vacuum into saturated barium hydroxide.

Table 3. Preferment formulae.

Ingredients	Type of preferment			
	1 Standard (Commercial)	2 Standard + vitamins[a]	3 Standard + "rope" inhibitor	4 Maltose + "rope" inhibitor
	Percentage of flour weight			
Water	70.0	70.0	70.0	70.0
Non-fat dry milk	4.0	4.0	4.0	4.0
Sucrose	4.0	4.0	4.0	....
Malt extract (non-diastatic)	0.5	0.5	0.5	2.0
Improver[b]	0.5	0.5	0.5	0.5
"Rope" inhibitor	....	....	0.4	0.4
Vitamin premix	....	0.1	....	....
Compressed yeast	3.0	3.0	3.0	3.0
Total:	82.0	82.1	82.4	79.9

[a] Additions required to bring to U.S.A. standards for vitamin enriched bread.
[b] Commercial bromate-type bread improver in a malt-flour base.

Then 0.1*N* hydrochloric acid was used to titrate the excess barium hydroxide with phenolphthalein indicator, and to titrate the barium carbonate using bromphenol-blue indicator.

The fermentation or gas production capacity of the preferments was determined by the method of Burrows and Harrison (1959) using 15 ml of the preferment in place of the yeast suspension specified.

Yeast growth is discussed later.

The preferments were made and kept at 87–88°F, and were continuously stirred. Suitable aliquots were withdrawn for analysis at zero, 60, 90, 120, and 150 min.

RESULTS

Biochemical changes in the preferments. *Fermentation of sugars.* The preferments are essentially anaerobic, alcoholic fermentations, the over-all utilization of carbohydrate being approximately expressed by the formula

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2 + 22 \text{ kcal}$$

Actually, the ethanol and carbon dioxide account for only 95% of the glucose utilized, some glycerol (3%) and succinic acid (0.6%) normally being formed. Traces of acetaldehyde, acetic acid, lactic acid, and fusel oil have also been reported.

In our experiments, the sucrose present was almost immediately inverted by the yeast, conversion of from 92.0 to 100.0% being noted at zero time. This agrees with the observation of Koch *et al.* (1954) that sucrose is completely inverted within a few minutes after the yeast is introduced.

In the preferments containing sucrose as the major sugar, the sugars disappeared at an almost uniform rate, as is seen in Fig. 2. Only that amount which corresponded approximately to the initial amount of lactose and maltose (1.73 and 0.34%, respectively, as invert sugar) remained in the standard and in the standard plus vitamins, whereas a little more remained in the standard plus "rope" inhibitor.

The figures were 8.8, 3.7, and 20.0%, respectively. Since the preferments were not analyzed for the individual sugars, we

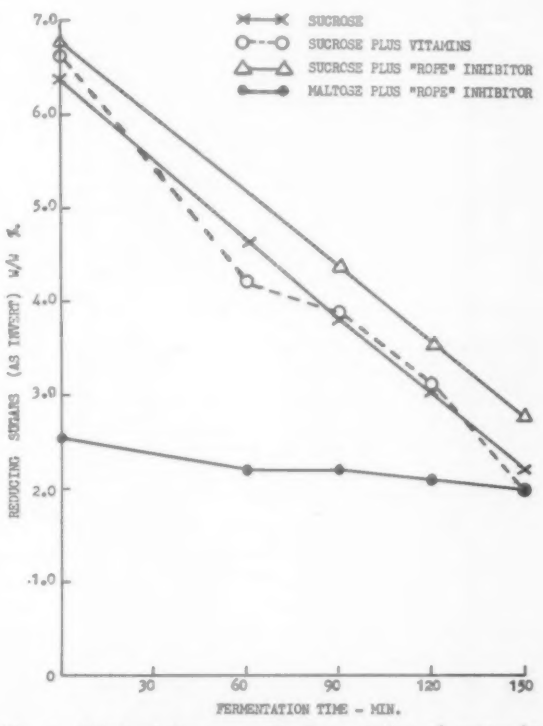


Fig. 2. Effect of time upon the fermentation of sugars in different preferments.

cannot say what percentage, if any, of the maltose was fermented.

However, Koch *et al.* (1954) have shown that maltose in the presence of glucose is fermented at a very slow rate, so it is reasonable to assume that maltose constituted the bulk of the remaining fermentable sugars.

In the preferment containing maltose as the only fermentable sugar the fermentation proceeded at a slower rate, 28% remaining after 2½ hours.

Alcohol production. As would be expected from the data in Fig. 2, appreciable alcohol production occurred from fermentation of the sugars, amounting to 1.60–1.73% w/w in the three preferments containing sucrose to 0.49% w/w in the maltose preferment. The data are shown in Fig. 3.

Changes in pH and total acidity of the preferment. In spite of the buffering ability of the dry milk solids, a marked increase in the acidity of all sucrose preferments (5.4 to 4.3 pH) was observed during the 2½-hour test period, but in the case of the maltose preferment the pH remained almost constant, varying from 5.10 to 5.05 (Fig. 4).

The changes in total acidity are shown in Fig. 5. There is a sharp, initial increase in acidity during the first 60–90 min of fermentation, followed by a marked decrease in the rate, and, in the case of the maltose preferment, a decrease during the last 30 min.

Carbon dioxide content of preferments. Saturation of the liquor with carbon dioxide occurred in the sucrose preferments by the end of the first hour, the concentration being approx 0.25% w/w. About half this level was reached in the maltose preferment only at the end of the test period.

Fermentative capacity of the preferments. Fig. 6 plots total gas production versus time. In the standard sucrose preferment, there was no change during the first 60 min, then a maximum was reached in 90 min, following which there was a slight decline. The addition of vitamins accentuated the maximum at 90 min, and greatly arrested the rate of decline. In fact, the difference between the 90- and 150-min figures were within the limits of experimental error (±1%). The gas production noted when maltose was used showed but little variation for 120 min, and then resulted in a maximum at 150 min. When a straight dough was made with the same flour and yeast, the gas production amounted to 100 ml.

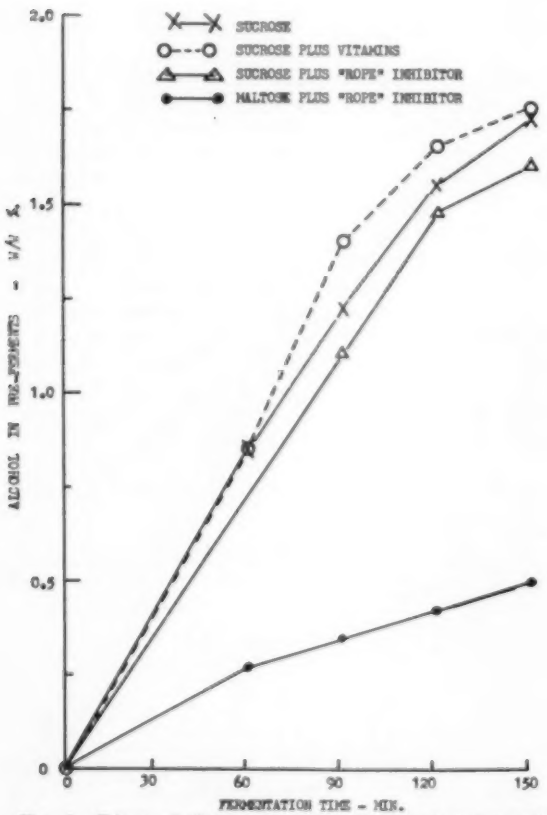


Fig. 3. Effect of time upon production of alcohol in different preferments.

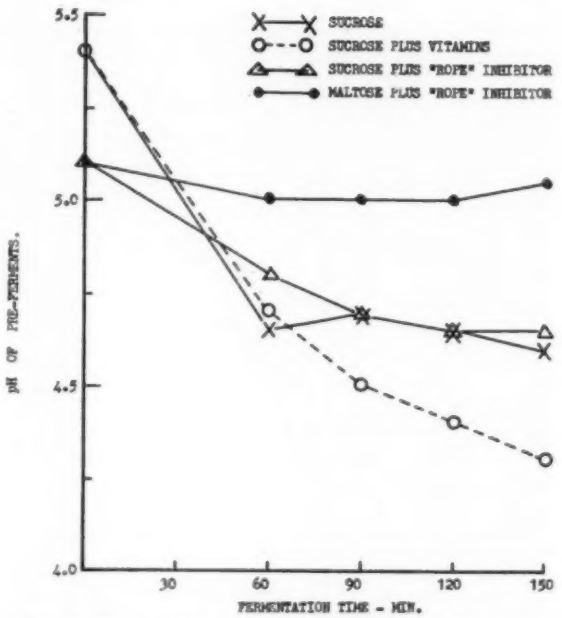


Fig. 4. Effect of time upon pH of different preferments.

Yeast behavior in the preferments. The most recent paper on yeast growth in doughs noted by us is by Thorn and Ross (1960). They found a yeast increase of about 35% in straight doughs of 3½-hr fermentation period, and no growth in flour ferments of the same duration although growth occurred to the extent of 16% in the doughs made from the ferments. These authors defined growth as cell increase as evidenced either by an increase in the number of single cells and/or by the formation of buds. They quantitatively recovered the yeast cells by gelatinizing the starch and then solubilizing both it and the protein by treatment with fungal amylase and protease. They then removed the lipids and after a further enzymic treatment obtained the yeast cells free of extraneous material. Naturally, after this treatment the yeast cells could not be expected to reflect their actual size *in vivo*—nor was such claimed by the authors. However, since an increase in size generally precedes budding and cell division, we decided to estimate growth by measuring the rate of change in cell size. This was done by taking an aliquot of the preferments at intervals of 0, 60, 90, 120, and 150 min, preparing slides, and making photomicrographs. The major and minor axes of 20 to 92 cells (all appearing in the field) were measured in each instance, the deviation of the mean at each interval from that at zero time was calculated and the t-test applied. By this means it was possible to calculate the probability that the samples were drawn from the same population. Here it should be remembered that a low probability indicates with a high degree of significance that cell size has changed.

Counts of budding cells were also made, but were too few (about 300 in each case) to permit statistical treatment.

The cell concentration at the beginning and end of each preferment was also determined by direct counts.

Briefly, the results (Table 4) were as follows:

Standard. By the end of 2 hr there was a highly significant ($P<1.0\%$) increase in yeast cell size—in both length and breadth—but after 2½ hr the cells were significantly larger only in breadth. Budding cells had increased from 1.5 to 9.5%.

Standard plus vitamins. The yeast cells in this preferment showed a highly significant increase ($P<0.5\%$) in size by the end of the first hour. This was maintained to the end of the fermentation. Budding increased from 1.9 to 8.1%.

Standard plus "rope" inhibitor. The growth pattern was somewhat similar to that of the standard insofar as significant increases in cell size were observed at the 1½- and 2-hr intervals. However, budding remained unchanged, at 1.6%.

Maltose plus "rope" inhibitor. The cells showed a significant increase in length and breadth after 1 hr, but this was not maintained. After 2½ hr the cells were significantly larger only in breadth.

The number of budding cells varied from 1.0 to 2.5% but this difference is not considered to be greater than the experimental error, i.e., no change was recorded.

For all preferments, direct counting of yeast cells showed an initial population of 330×10^6 to 530×10^6 per ml, and a final concentration of 410×10^6 to 540×10^6 per ml. The maximum increase was noted with the preferment containing added vitamins (330×10^6 to 410×10^6 cells/ml) but the statistical validity of these observations has not been established.

BAKING TESTS

Initially attempts were made to produce bread from a preferment by mixing it with flour (protein 10.8%, ash 0.44%), fat (shortening), and oxidizing agent (potassium bromate from 10 to 30 ppm) in a high-speed Morton Mixer and then transferring the dough directly to the baking pans. These were unsuccessful since the resultant bread showed no "oven-spring" and possessed immature characteristics. The next, and more successful, method consisted of mixing the preferment and other ingredients for 3 min, as before, and then immediately transferring the dough into a hopper feeding a gear pump. This pumped the dough into a length of pipe of 2 in. diam under a pressure of 50 lb/sq. in. The dough was then extruded through a standard stainless-steel ½-in. plug cock into the bread tin. It was then baked after 45 minutes' proof at 95°F.

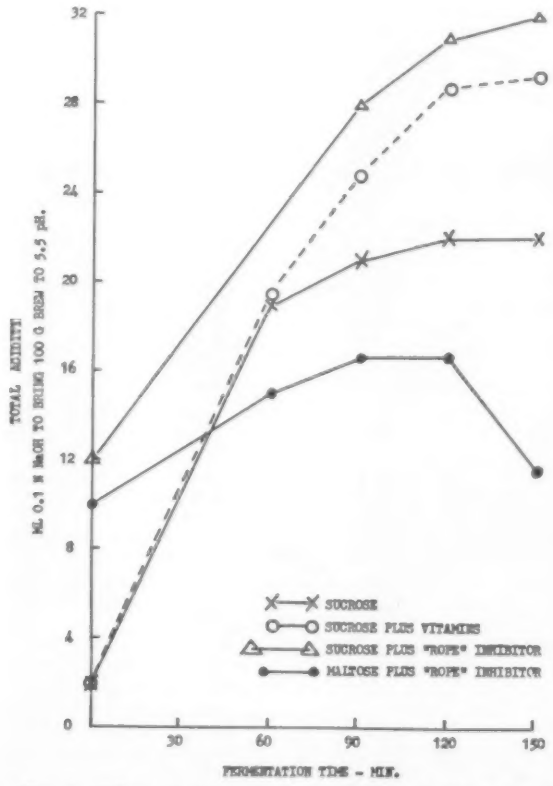


Fig. 5. Effect of time upon total acidity of different preferments.

Table 4. The effect of preferment composition upon growth of yeast cells.

Preferment	Time (hr)	Cells measured	Mean lengths (μ)	Mean breadth (μ)	Budding cells (approx 300 counted) (%)	Cells present (millions/ml)
Standard	0	46	5.8	4.2	1.5	440
	1	52	6.2	4.7	4.5	
	1½	52	6.3	4.7	5.1	
	2	42	6.7**	5.0**	8.1	
	2½	27	6.1	4.7*	9.5	456
Standard plus vitamins	0	46	5.6	3.9	1.9	330
	1	46	6.1**	4.4**	2.0	
	1½	56	6.3**	5.0**	1.6	
	2	56	6.4**	5.1**	3.6	
	2½	37	6.2*	4.7**	8.1	410
Standard plus "rope" inhibitor	0	51	5.7	3.9	1.6	480
	1	92	5.9	4.2	....	
	1½	56	6.1*	4.5**	....	
	2	51	5.8	4.4**	....	
	2½	51	6.3	4.6	1.6	500
Maltose plus "rope" inhibitor	0	30	5.7	3.9	1.0	530
	1	20	6.4*	4.7**	2.5	
	2	25	5.7	4.2	2.2	
	2½	24	5.9	4.4*	2.5	540

*Significant at 5% level.
**Significant at 1% level.

The resultant bread had the uniform texture, tender crumb, and crumb color characteristic of bread made by the Do-Maker process, but the processing time of about 20 min was thought to be too long to be representative of the commercial process and to cloud the issue of different preferments, particularly that containing maltose. In any case, the operation was cumbersome and extravagant of labor. The two preferments tested in this way were the sucrose and maltose ones containing "rope" inhibitor. There was no difference in the physical characteristics of the bread, but a taste panel voted 5 to 2 in favor of the "sucrose" bread. This is not to infer that there was a marked difference, for there was not; the "sucrose" bread was bland in flavor and the "maltose" bread was very slightly malty.

The levels of oxidizing agent used, obtained empirically, were much higher than is normal in the conventional process. It is believed (Mitchell and Crawford, 1960) that the severe action of the dough developer causes a "greening" effect to an extent that quantities of oxidizing agent sufficient to cause an initial overmaturity are required to achieve optimum maturity at the end of the process, but we have not examined this aspect. Potassium iodate was not used, since it is not permitted by Australian Pure Food Regulations.

DISCUSSION

The continuous system of breadmaking as evidenced by the Do-Maker process, differs from the conventional procedure in several important respects. The dry non-fat milk solids are in the presence of excess water for 2½-hr, thereby becoming completely hydrated before being mixed with the flour. The dough contains less solids and is mixed at very high speed with a dilute, acid alcoholic salt solution, which it is reasonable to assume assists the rapid modification of the gluten since it would tend to solubilize the glutenin. The shortening is added in liquid form at 140°F, thereby assisting in rapid, uniform dispersal.

The yeast has been pre-conditioned to its environment and has established a fermentative capacity greater by 7–10% than it initially possessed. The dough liquor is initially saturated with CO_2 (under our test conditions it contained about 85 ml CO_2/100

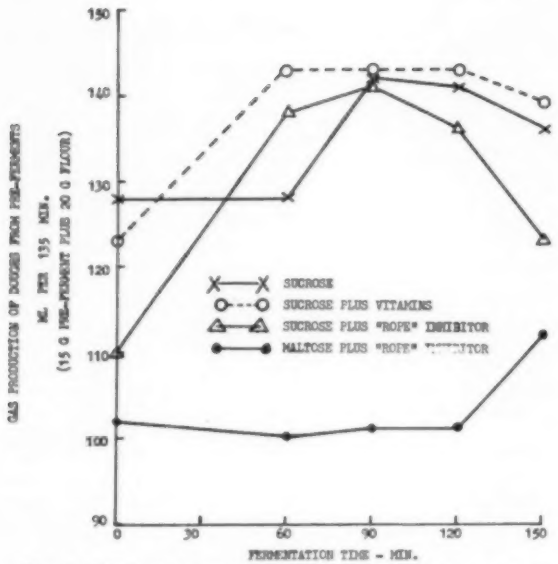


Fig. 6. Effect of fermentation time of preferments upon gas production of doughs made therefrom.

ml), so that with increase in temperature, evolution of CO_2 proceeds uniformly throughout the dough mass. Possibly this is one reason for the very fine uniform crumb texture that is so characteristic of this bread. Since the dough temperature is 92–100°F, depending on tin-proof conditions, the rate of enzymic reactions is between two and three times as rapid as at conventional dough temperatures. This is apparently not deleterious to bread quality, while helping to speed bakery operations.

Consideration of the results given above show that the standard sucrose preferment followed the course of a normal fermentation. The decrease in sugar was accompanied by an increase in acidity, in alcohol, and in carbon dioxide. After 90 min an increase in fermentative capacity was noted that tended then to decrease, though after 2½ hr it was still appreciably greater than the initial value. The variation in yeast cell size was somewhat similar to the gas production, the cells being at maximum size at the 120-min interval.

The fermentation pattern was maintained when a "rope" and mold inhibitor, sodium diacetate, was added to the preferment, but yeast activity was slightly inhibited. This was shown by the slightly lower rate of sugar utilization, slightly lower fermentative capacity, and inhibition of budding. However, the inhibition was not sufficient to be reflected in the bread made from the preferment.

Addition to the standard preferment of thiamin, riboflavin, and niacin in amounts such that the resultant bread would comply with U.S.A. standards for enriched bread had beneficial results. We presume they stimulated yeast growth since the cells showed an early, highly significant increase in size. This was reflected in a sustained increase in fermentative capacity without an alteration in the general pattern of sugar utilization, alcohol production, etc.

Varying the preferment formula by substituting maltose (in the form of non-diastatic malt-extract) for sucrose on an equivalent economic basis was done to test its effect not only on fermentation but also on bread flavor. The rate of fermentation was markedly lowered. Nevertheless, during the last half-hour of fermentation some interesting changes occurred that were different from those experienced in other cases. For example, the acidity decreased and the fermentative capacity increased. These changes have not yet been explained; possibly, some metabolism of the organic acids occurred. The resultant bread was different in flavor.

It has been claimed, we believe with justification, that the flavor of bread made from preferments is controlled not only by the nature of the major ingredients but also by its micro-floral content (Robinson *et al.*, 1958).

Because of the similarity of the major ingredients in our experiments, a micro-floral survey was not made.

Variations in the length of the preferments were not attempted, but indications are that 2 hr would have proved satisfactory. Probably this point could be best elucidated under commercial conditions.

ACKNOWLEDGMENTS

The work reported represents the efforts of the staff of M.B.T. Research Laboratory Pty. Limited. In particular, credit is due to Mrs. D. W. Kinsey for the yeast cell measurements and to Messrs. Long, Kinsey, Allman, and Brooks for analytical and baking assistance.

Thanks are also expressed to the directors of Mauri Brothers & Thomson Limited for permission to publish this paper, and to Messrs. Wallace and Tiernan Pty. Ltd. for permission to reproduce Fig. 1.

REFERENCES

Baker Process Co. 1960.

Bates, F. J., and Associates. 1942. Polarimetry, saccharimetry and the sugars. U. S. Dept. of Commerce Nat. Bur. of Stnds. Circular 440. U. S. Govt. Printing Office.

Bottomley, R. A. 1956. Bread for the millions. *Food Technol. in Australia* **8**, 599–611.

Burrows, S., and J. S. Harrison. 1959. Routine method for determination of the activity of baker's yeast. *J. Inst. Brewing* **65**, 39–45.

Food Eng. 1956. Flour to fermented dough in 2 minutes. *Food Eng.* **28**, 98-101. Oct.

Koch, R. B., F. Smith, and W. F. Geddes. 1954. The fate of sugars in dough and synthetic nutrient solutions undergoing fermentation with baker's yeast. *Cereal Chem.* **31**, 55-72.

Lawler, F. K., and J. V. Ziemba. 1956. How engineering revolutionizes old art of breadmaking. *Food Eng.* **28**, 74–79. Oct.

Milgate, H. G. 1960. Automation in the Baking Industry in Australia. *Australasian Baker.* 5–16, July.

Miller, B. S., and J. A. Johnson. 1958. Present knowledge concerning baking processes employing preferments. *Wallerstein Labs. Communs.* **21**, 115–132.

Mitchell, T. A., and C. A. Crawford. 1960. Note on breadmaking without bulk fermentation: The effect of mixing and stage of addition of potassium iodate. *New Zealand J. Sci.* **3**, 290.

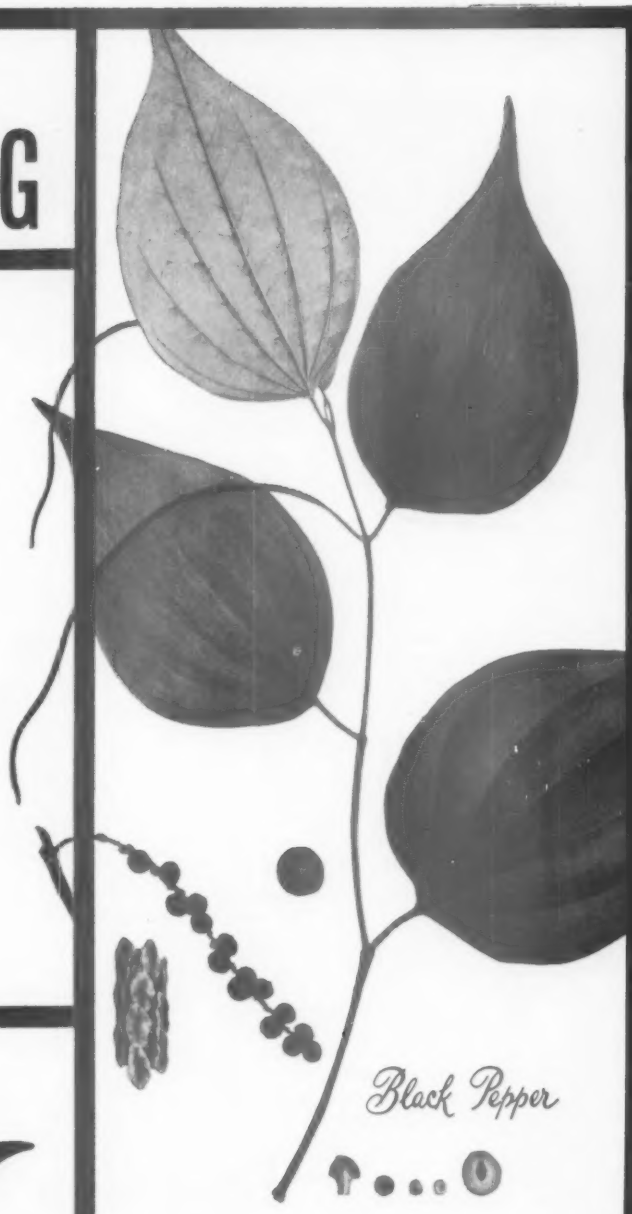
Robinson, R. J., T. H. Lord, J. A. Johnson, and B. S. Miller. 1958. Studies on the decrease of the bacterial population in preferments. *Cereal Chem.* **35**, 306–317.

Thorn, J. A., and J. W. Ross. 1960. Determination of yeast growth in doughs. *Cereal Chem.* **37**, 415–421.

FREEZE DRYING

D&O offers SPISOSEAL the latest development in seasonings for foods of the future. SPISOSEALS are extractions of natural spices, spray dried for absolute flavor stability and unsurpassable shelf life. Full, instant release of flavor, aroma and strength . . . highly recommended for freeze dried foods. Write the D&O Dry Materials Division, 249 Goffle Road, Hawthorne, N. J., for detailed information.

Write for copy of Spisoseal booklet



DODGE & OLCOTT, INC

MANHATTAN INDUSTRIAL CENTER

SEVENTY-FIVE 9TH AVE. NEW YORK 11, N. Y.

SALES OFFICES IN PRINCIPAL CITIES OUR 162ND YEAR OF SERVICE

D&O ESTABLISHED 1798

FLAVOR BASES
ESSENTIAL OILS
AROMATIC CHEMICALS
DRY FLAVORINGS
AND SEASONINGS

KELCO COMPANY

technical bulletin

Use unique Kelco Algin Colloids to improve your food products

In Frozen Foods, Kelcoloid, in acid to neutral foods having oil-water systems, provides emulsion stability. Coarse ice crystal formation is retarded. Kelcoloid holds structure of food, maintains smooth uniform texture, and promotes complete flavor release.

In Gravies, and in Cream, Meat and Barbecue Sauces, Kelcoloid provides efficient emulsion stability, and aids in thickening and bodying, too. Kelcoloid produces properly stabilized, free-flowing sauces that are homogenous and eye appealing, with clean full flavor. Shelf life is measurably extended.

In Salad Dressings, Kelcoloid, highly efficient stabilizer, prevents body separation and markedly increases shelf life. Kelcoloid promotes a uniform, smooth consistency giving dressings a highly desirable, palatable appearance.

No Surer Way to Achieve Effective Emulsion Stability

KELCOLOID HVF, the high viscosity member of this series, is generally recommended for use where a decided increase in viscosity is desired along with effective emulsion stability.

KELCOLOID LVF, the low viscosity member of this algin series, produces excellent emulsion stability and desirable body qualities. The LVF is recommended for use where a high degree of emulsion stability is desired with a minimum change in viscosity and body properties.

YOURS ON REQUEST: Free samples of KELCOLOID and other Kelco algin products, plus Technical Data describing properties, advantages and uses. At your service, too, are highly qualified food technicians ready to give individual attention to your problems. Write without obligation to your nearest Kelco regional office.

Kelcoloid HVF® Kelcoloid LVF® products of Kelco Company

75 Terminal Avenue, Clark, N. J. • 20 N. Wacker Drive, Chicago 6, Ill. • 530 W. Sixth Street, Los Angeles 14, Calif.
Cable Address: KELCOALGIN — CLARKNEWJERSEY

Survival of Bacteria of Public Health Significance in Frozen Sea Foods[a,b]

(Manuscript received May 10, 1961)

H. Raj and J. Liston
College of Fisheries, University of Washington, Seattle, Washington

SUMMARY

In frozen processed sea foods stored at 0°F for periods up to 648 days, total viable counts at 68 and 95°F showed less than a tenfold decrease, coliform count declined comparably in uncooked samples but more steeply in precooked samples, and enterococci showed fluctuations but little or no net decrease in either type of sample. Studies of the effects of freezing (–30°F) and storage at 0°F on six selected species of microorganisms associated directly or indirectly with potential food-poisoning hazards showed that in brain heart infusion broth suspensions, after 393 days at 0°F, *Salmonella typhimurium* was virtually eliminated, *Escherichia coli* and *Staphylococcus aureus* were greatly reduced in number, *Streptococcus pyogenes* counts were slightly reduced, and *Streptococcus bovis* and *Clostridium perfringens* were little affected. When suspended in sterilized fish homogenate (FH), *S. typhimurium* and *S. aureus* were reduced tenfold in 393 days at 0°F, while the rest of the cultures were not significantly affected.

Simultaneous studies of the effects of multiple cyclic defrosting showed that in broth suspensions, *S. typhimurium* and *E. coli* were virtually eliminated after the third and fourth cycle, respectively, *S. aureus* and *S. pyogenes* were reduced ten-thousandfold and seventyfold, respectively, after the fifth cycle and *S. bovis* and *C. perfringens* were little affected by five cycles. In FH, *E. coli*, *S. aureus*, and *S. typhimurium* survived through the fifth cycle in numbers sufficient to constitute a public health hazard. *S. pyogenes*, *S. bovis*, and *C. perfringens* were little affected under similar conditions. The pure-culture studies thus confirmed the protective effect of sea-food materials against bacteria, and provide a partial explanation of the findings with commercially prepared frozen sea foods.

THE IMPORTANCE of frozen foods in the nation's diet has stimulated many studies of the effects of freezing and low-temperature storage on the bacteria associated with foods (Borgstrom, 1955; Frazier, 1958). From the public health point of view, particular interest has been shown in reports indicating the survival of bacteria that have been frequently implicated, directly or indirectly, with potential food-poisoning hazards (Gunderson and Rose, 1948; Kereluk and Gunderson, 1959; Kereluk *et al.*, 1961; Larkin *et al.*, 1955).

In general, the effect of freezing on bacteria depends on various factors such as: rate and type of freezing (Luyet and Gehenio, 1940), temperature and duration of storage (Weiser and Osterud, 1945), initial numbers, types, and stages of growth phase of microorganisms involved (Hess, 1934; Record and Taylor, 1953), thawing processes, number of cyclical defrostings (Hess, 1934; Weiser and Hargiss, 1946), and the physical protection offered by the food itself or its components (Haines, 1937; Hess, 1934; Keith, 1913; Smith *et al.*, 1951; Squires and Hartsell, 1955; Woodburn and Strong, 1960).

There are few reported studies of the incidence and survival of bacteria of public health significance in frozen sea foods. In particular, there is little information available on the protective effects of sea-food components against the lethal effects of freezing and low-temperature storage. Also, very little is known about the effects on bacteria of public health significance of repeated freezings and thawings of frozen foods such as may occur during transit from processing plants to warehouses, retail markets and customers.

The work described here was undertaken as part of a general study of the public health bacteriology of frozen sea foods and was designed to provide information on the effects of freezing and subsequent prolonged low-temperature storage, and of multiple cyclical defrostings, on bacteria inoculated into fish products. A particular feature of the study was simultaneous evaluation of the effects on a number of bacteria chosen as representative of fecal indicator organisms and potential food-poisoning pathogens.

EXPERIMENTAL METHODS

Commercial frozen samples. For preliminary studies of the effects of freezing and low-temperature storage on the survival of bacteria of public health significance in frozen sea foods, 5 samples of frozen breaded (uncooked) oysters and 7 samples of frozen precooked fish sticks obtained from a local processing plant, were stored at 0°F up to 648 days. Representative portions (200 g) of each sample were withdrawn at three different intervals and tested simultaneously for total viable counts at room temperature (RT, *ca* 68°F), and at 95°F, and for most probable numbers (MPN) of coliforms and enterococci. Preparation of samples was described elsewhere (Raj and Liston, 1961a). Total viable counts were made from samples homogenized with phosphate buffer (pH 7.2) plated on trypticase glucose yeast extract (TGE) agar. MPN counts of coliforms were determined by the standard procedure with lauryl sulfate (LS) broth, followed by confirmatory test in brilliant-green bile (BG) broth. Enterococci were determined by our modified procedure, reported elsewhere (Raj and Liston, 1961b).

Frozen pure cultures. For studies of the effects of freezing and low-temperature storage, and multiple cyclic defrosting, the organisms used were: *Escherichia coli* K12, *Streptococcus pyogenes*, *Streptococcus bovis*, *Staphylococcus aureus* (phage type 77), *Salmonella typhimurium*, and *Clostridium perfringens*. All cultures were grown in brain heart infusion (BHI) broth except *C. perfringens* (grown in cooked-meat medium), and were incubated 16 hr at 98.6°F. Each culture was then diluted with sterile phosphate-buffered water to give a reading of about 85% light transmittance on a Coleman spectrophotometer

[a] Work was supported by National Institutes of Health Grant No. RG-5932.

[b] Contribution No. 122, College of Fisheries, University of Washington, Seattle.

(Universal model) at 650 mμ. At this per cent transmission, each suspension roughly matched Brown's opacity tube No. 1, and thus were obtained the approximate numbers of bacteria (Cunningham and Timothy, 1924) in each suspension. Equal quantities of each original broth culture, roughly calculated to provide a final concentration of 10^5 organisms per ml, were then inoculated into 500 ml of chilled BHI broth and 500 ml fish homogenate (FH), made by blending 200 g of sterilized precooked fish sticks with 300 ml of buffered water. Suspensions in broth and fish homogenate for each organism were then separately distributed in 50-ml quantities into wide-mouth hard-polyethylene (8-oz capacity) bottles. All bottles were then immediately placed directly on refrigerated coils in a freezing chamber set at −30°F, and held there overnight. The next day the bottles were removed to 0°F for storage.

Initial viable count. Serial decimal dilutions of each sample were made in buffered water and inoculated into plates using TGE agar medium for most cultures, blood agar (BA) medium for *S. pyogenes*, and Brewers' anaerobic agar (BAA) medium for *C. perfringens*. At least two consecutive dilutions were used, and aliquots of each dilution were inoculated per plate so as to get counts between 30 and 300 per plate. Four plates were made for each dilution. All plates were incubated at least 48 hours at 98.6°F. Plates made of the *Clostridium* culture were given a second layer of the BAA medium and placed in a vacuum desiccator, which was then partially evacuated for ½ hr with a vacuum pump and incubated at 95°F. Only counts within the practical margin of ±20% experimental error were considered; on the few occasions when this margin was not found applicable, because of the large differences in counts, an average of counts made on all the plates was taken into consideration. The final count thus obtained for each organism provided the initial number of viable cells present in each preparation before it was subjected to freezing and low-temperature storage.

Freezing and low-temperature storage. For studying the effects of freezing and prolonged storage, one bottle of frozen broth suspension and one bottle of frozen FH suspension for each of the six cultures was withdrawn each time from cold storage, thawed, tested, and discarded. Such samples were withdrawn after 40, 90, 130, 277 and 393 days at 0°F.

Multiple cyclic defrostings. To determine the effects of multiple cyclic defrostings, one bottle of each frozen preparation, labeled specifically for this purpose, for each of six organisms was removed from cold storage and thawed. After aliquots were withdrawn for testing, the bottles were immediately put in the freezing chamber at −30°F, left overnight, and the next day removed to storage at 0°F. To facilitate comparison between the effects of freezing followed by prolonged storage and the effects of multiple cyclic defrostings, the preparations in this study were also tested after 40, 90, 130, 277, and 393 days.

Thawing procedure. All frozen preparations were thawed in a constant-temperature water bath at 113°F—for 10 min in the case of broth preparations and for 15 min in the case of FH preparations. In both cases the final temperature was close to 41°F. After thawing they were held in a water bath at 41°F for a few minutes until the serial dilutions were made and inoculated. Plating and counting procedures were as described above for initial viable count.

RESULTS

Fig. 1 and 2 show the effects of low-temperature storage on the total viable counts at RT and 95°F, and MPN counts of coliforms and enterococci in frozen breaded (uncooked) and precooked sea food samples. The apparent decline in viable counts in both types of sea foods was less than tenfold even after over 20 months at 0°F. Compared to enterococci counts, numbers of coliforms were relatively reduced, much more so in precooked samples, where they were initially present in much lower numbe.., presumably as a result of the precook treatment. Enterococci apparently were not affected at all in precooked samples, but in uncooked samples showed some increase during the first 300 days at 0°F, and a decline thereafter.

Table 1 shows the effects of 0°F on pure cultures of *S. pyogenes*, *S. bovis*, and *C. perfringens*. There was little change throughout storage in the numbers of these organisms in either BHI or FH, except for a transient increase in counts of *S. pyogenes* and *C. perfringens* in FH after 40 days.

S. aureus in FH showed a slight reduction (sevenfold) during the first 130 days but little change thereafter, whereas in BHI broth it showed a large reduction (thirtyfold) during the first 40 days, followed by a slow steady decline, which after 393 days totaled about five-hundredfold reduction from the inital count (Table 1).

Fig. 3 shows results with *E. coli* and *S. typhimurium*. No significant reduction in numbers of *E. coli* occurred in FH, though the corresponding culture in BHI broth showed a marked decline of over one-hundredfold by 277 days.

S. typhimurium showed the most profound effects: a somewhat irregular count during the first 130 days in FH, and thereafter a slow decline (over tenfold after 393 days), but a very marked reduction (about ten-thousandfold) in BHI during the first 130 days, and little further change up to 393 days. Apparently there was no effect on *S. bovis* in either medium, and on *C. perfringens* in BHI broth. *C. perfringens* in FH, however, actually showed a marked increase (twentyfold) in count during the first two cycles, and thereafter remained unchanged (Table 1).

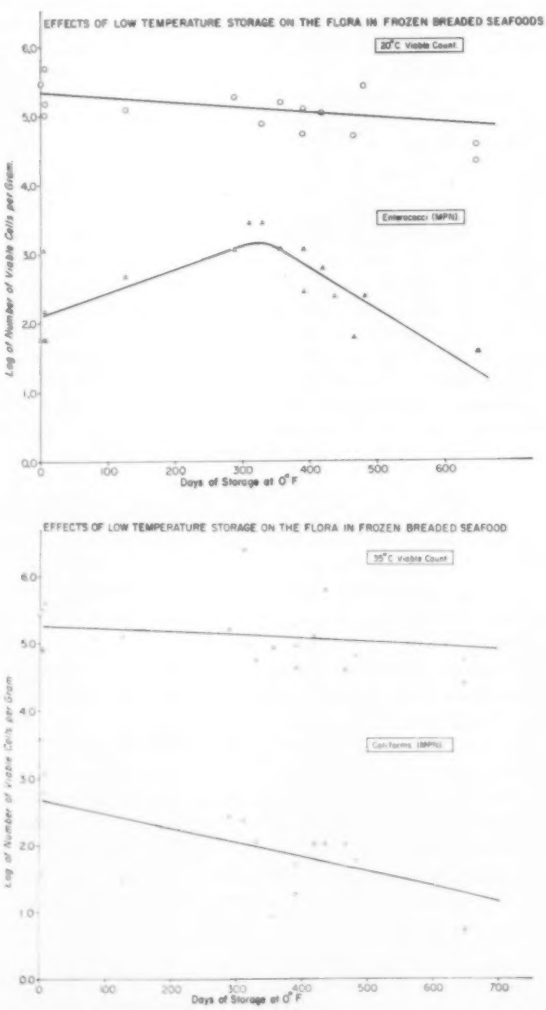

EFFECTS OF LOW TEMPERATURE STORAGE ON THE FLORA IN FROZEN BREADED SEAFOODS
20°C Viable Count
Enterococci (MPN)
Log of Number of Viable Cells per Gram
Days of Storage at 0° F
EFFECTS OF LOW TEMPERATURE STORAGE ON THE FLORA IN FROZEN BREADED SEAFOOD
35°C Viable Count
Coliforms (MPN)
Log of Number of Viable Cells per Gram
Days of Storage at 0° F

Fig. 1. Effects of low-temperature storage on the flora in frozen breaded sea foods.

S. aureus in FH showed a sixtyfold reduction during the first three cycles, and little change thereafter. In BHI broth, the major decline (*ca.* thousandfold) also occurred during the first 3 cycles, but counts continued to fall through the fifth cycle, totaling a ten-thousandfold reduction. *S. pyogenes* decreased very slightly in FH, but in BHI showed over a seventyfold reduction by the fifth cycle. Fig. 4 shows sensitivities of *E. coli* and *S. typhimurium* to repeated freezings and thawings. *E. coli* in FH was not affected over the first cycle but declined (tenfold) during the next 3 cycles and remained practically unaffected thereafter. In BHI broth, *E. coli* was reduced one-thousandfold in the first three cycles, and then more slowly, to extinction by the last cycle. In FH over two-hundredfold reduction of *S. typhimurium* occurred during the first three cycles, and little change thereafter. In BHI broth, numbers reduced sharply (five-hundredfold) during the first cycle and were reduced to extinction by the end of the fourth cycle.

DISCUSSION

Observations during our general study of the incidence of various types of microorganisms (particularly coliforms, *E. coli*, enterococci, hemolytic streptococci, coagulase-positive staphylococci, and sporing anaerobes), even after prolonged low-temperature storage, indicated that such sea foods probably protected these organisms against the lethal effects of freezing (Raj and Liston, 1961a, b). The preliminary experiments (Figs. 1, 2) with commercialiy prepared sea-foods further strengthen this conclusion, and agree well with the findings of other workers concerning the survival of both psychrophilic and mesophilic bacteria (Gunderson and Rose, 1948; Kereluk and Gunderson, 1959; Larkin *et al.*, 1955; Proctor and Phillips, 1948).

The studies with pure cultures of organisms of public health significance provide some measure of the extent of this protection for individual organisms representative of the main types, and yield basic information on the general sensitivity of these organisms to low temperatures. The protective effects of sea foods were most marked with *S. typhimurium*, *E. coli*, and *S. aureus* (Fig. 3 and Table 1). In broth preparations, *S. typhimurium* was virtually eliminated, and *E. coli* and *S. aureus* were greatly reduced in numbers after 393 days at 0°F, whereas in FH the *Salmonella* and staphylococcus cultures were reduced only tenfold and *E. coli* was little affected under similar conditions.

The extent of such protection might be expected to differ with type of substrate, temperatures of freezing and storage, and duration of storage. This was clearly demonstrated in the earlier pure-culture studies of Keith (1913), and Haines (1937), and later by Weiser and Osterud (1945). More recent studies have confirmed the variability of effect in foods (Borgstrom, 1955; Gunderson and Rose, 1948; Kereluk *et al.*, 1961; Proctor and Phillips, 1948; Squires and

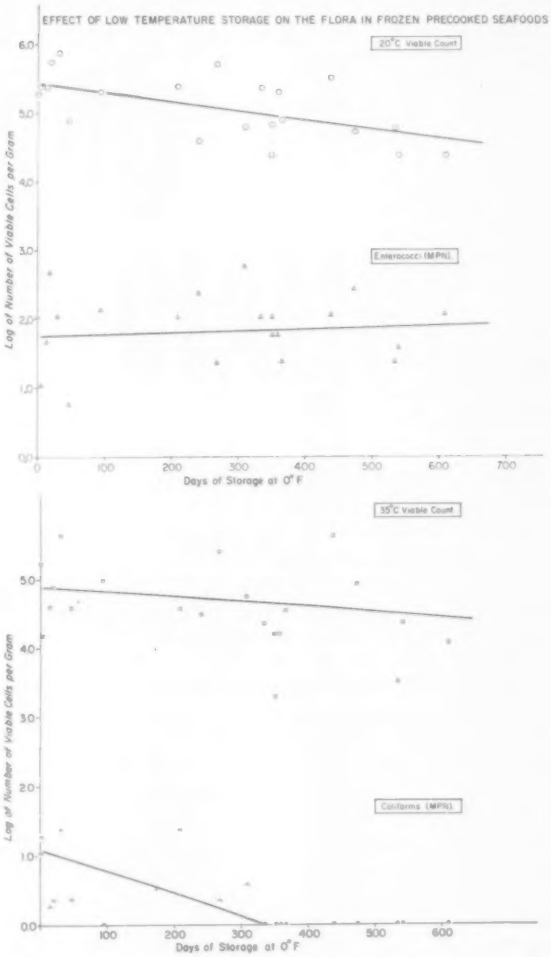

EFFECT OF LOW TEMPERATURE STORAGE ON THE FLORA IN FROZEN PRECOOKED SEAFOODS
20°C Viable Count
Enterococci (MPN)
Log of Number of Viable Cells per Gram
Days of Storage at 0° F
35°C Viable Count
Coliforms (MPN)
Log of Number of Viable Cells per Gram
Days of Storage at 0° F

Fig. 2. Effects of low-temperature storage on the flora in frozen precooked sea foods.

Table 1. Effects of low-temperature storage and multiple cyclic defrosting on various microorganisms.[a]

Pure cultures	Initial count	Counts after storage[b] at 0°F for: 40 days	90 days	130 days	277 days	393 days	Counts after cyclic[c] thawing and refreezing: 2nd 90 days	3rd 130 days	4th 277 days	5th 393 days
BHI broth suspensions										
S. bovis	750	790	750	710	1010	478	.....	520	810	495
S. pyogenes	1500	860	790	800	550	489	330	296	63	20
Staph. aureus	1700	50	32	18	10	3.5	7	2.5	0.5	0.2
Cl. perfringens	650	710	735	700	700	670	620	710	920	604
Fish homogenates										
S. bovis	750	750	1330	910	1030	1235	610	713	560	598
S. pyogenes	1500	3000	1320	1150	850	763	2440	2050	880	550
Staph. aureus	1700	510	312	225	206	177	114	28	8.5	6.2
C. perfringens	650	3520	500	306	340	563	13400	14200	11500	9200

[a] All counts expressed as $\times 10^3$ per ml.
[b] Cultures were sharp frozen at −30° F overnight and then stored at 0°F.
[c] Cultures sharp-frozen and stored 40 days at 0°F (Cycle 1), refrozen at −30°F, then stored, thawed, and refrozen at the times noted.

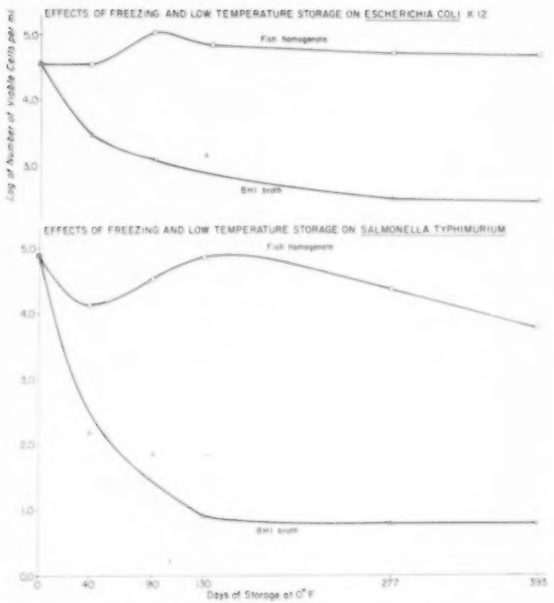

EFFECTS OF FREEZING AND LOW TEMPERATURE STORAGE ON ESCHERICHIA COLI K 12
Log of Number of Viable Cells per ml
Fish homogenate
BHI broth
EFFECTS OF FREEZING AND LOW TEMPERATURE STORAGE ON SALMONELLA TYPHIMURIUM
Fish homogenate
BHI broth
Days of Storage at 0° F

Fig. 3. Effects of freezing and low-temperature storage on *Escherichia coli* K12 and *Salmonella typhimurium*.

Hartsell, 1955; Woodburn and Strong, 1960). The wide variety of conditions used by previous workers makes it extremely difficult to compare our results with those in the literature. In particular there seem to have been few studies in which several bacterial species have been compared simultaneously for sensitivity to freezing under identical conditions.

Nevertheless, rough comparisons are possible in a few instances. The survival of *S. typhimurium* in FH is similar to the survival of this organism in rice flour and egg white (Woodburn and Strong, 1960), and comparable with the survival of *S. enteritidis* in chicken à la king and in creamed salmon (Proctor and Phillips, 1948). *S. bovis* and *S. pyogenes* showed survival in FH similar to that of *S. faecalis* in chicken gravy (Kereluk *et al.*, 1961), rather better survival than that of *S. faecalis* in corn syrup and rice flour (Woodburn and Strong, 1960), and very much better survival than that of an alpha-type streptococcus suspended in chicken à la king, creamed salmon, beef stew, and cooked shrimp (Proctor and Phillips, 1948).

The reported survival of *S. aureus* in chicken gravy (Kereluk *et al.*, 1961) is similar to that in FH found in this study, and survival in both of these products is very much better than in egg white, rice flour, or corn syrup (Woodburn and Strong, 1960). The survival of *E. coli* in FH is comparable to its reported survival in yeast extract veal infusion broth supplemented with 5% glycerol (Squires and Hartsell, 1955) and in chicken gravy (Kereluk *et al.*, 1961). Surprisingly, Kereluk *et al.* (1961) found no kill of the organisms discussed above, in BHI broth at 8.6°F. This is contrary to our findings, and to comparable observations of Squires and Hartsell with *E. coli;* we are at a loss to explain this difference. However, in all comparisons it is necessary to keep in mind the highly specific nature of cold sensitivity since it is well recognized that species of the same bacterial genus, and possibly even strains of a single species, may vary more or less widely in resistance.

Multiple freezings and thawings have been reported to be much more detrimental to bacteria than a single freezing and storage cycle (Borgstrom, 1955). Hilliard and Davis (1918) reported the complete elimination of typhoid bacilli and *Bacillus prodigiosus (Serratia marcescens)* by freezing and thawing four and five times, respectively, and Hilliard *et al.* (1915) showed similarly aggravated effects of multiple freezings and thawings on *E. coli*, and to a lesser extent on *B. subtilis*. Our studies have confirmed this point at least so far as the "sensitive" organisms *S. typhimurium*, *E. coli*, *S. aureus*, and, to a degree, *S. pyogenes* are concerned. However, there was a profound difference in the survival of these organisms in FH and in BHI broth. Thus, even under these stringent conditions FH exerted a protective effect (Fig. 4).

So far as the individual organisms were concerned, a definite order of sensitivity seemed apparent. *S. typhimurium* was most sensitive, followed in order by *E. coli*, *S. aureus*, *S. pyogenes*, *S. bovis*, and *C. perfringens*. Indeed, *S. bovis* and *C. perfringens* were quite resistant to freezing and cold storage.

In general, three possible effects of cold shock on

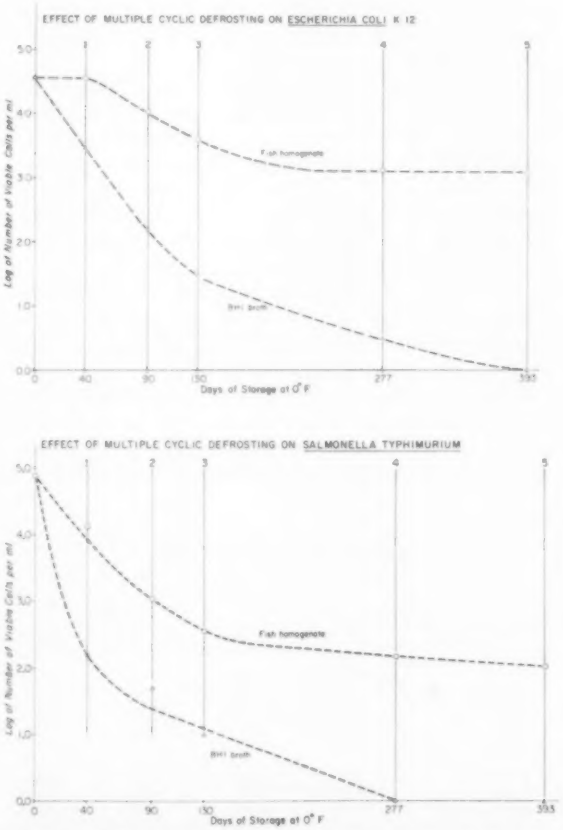

EFFECT OF MULTIPLE CYCLIC DEFROSTING ON ESCHERICHIA COLI K 12
Log of Number of Viable Cells per ml
Fish homogenate
BHI broth
Days of Storage at 0° F
EFFECT OF MULTIPLE CYCLIC DEFROSTING ON SALMONELLA TYPHIMURIUM
Fish homogenate
BHI broth
Days of Storage at 0° F

Fig. 4. Effect of multiple cyclic defrosting on *Escherichia coli* K12 and *Salmonella typhimurium*.

"HIRE" THIS FOOD SPECIALIST...

NO SALARY REQUIRED!

- **Years of practical experience in solving food production problems!**
- **Can help with your vitamin enrichment and fortification procedures**
- **Offers unlimited supply of vanillin**
- **Know-how of years of leadership in color field**

THIS FOOD SPECIALIST is a Sterwin Technically-Trained Representative . . . an expert with technical and practical experience to help you produce better food products more easily and economically.

He's cut time, expense, production steps in dozens of cases . . . is relied on by food manufacturers (large, medium, small) for prompt solutions to color, vitamin, vanillin and other food ingredient problems.

For a new production set-up, or to improve an existing one . . . see your local Sterwin Representative . . . costs you nothing . . . can save you plenty.

Sterwin Chemicals INC.

Subsidiary of Sterling Drug Inc

1450 Broadway, New York 18, N.Y.

What will the foods of the future be like ?

PFIZER PRODUCTS FOR THE FOOD INDUSTRY
MILLING & BAKING
Bi-Cap (flour enrichment mixtures); L-Lysine; Glucono-Delta-Lactone; Cream of Tartar; Citric Acid; Sorbistat®-K (Potassium Sorbate); Sodium Benzoate; B Vitamins; Sol-U-Pak
DESSERT
Citric Acid, Ascorbic Acid, Sodium Citrate, Fumaric Acid, Calcium Cyclamate, Calcium Gluconate, Sorbistat® (Sorbic Acid), Sorbistat®-K (Potassium Sorbate)
CANDY
Citric Acid, Ascorbic Acid, Calcium Cyclamate, Tartaric Acid, Cream of Tartar, Sorbistat® (Sorbic Acid)
FROZEN FOOD
Citric Acid, Ascorbic Acid, A-C-M®
MEAT PACKING
Citric Acid, Ascorbic Acid, Erythorbic Acid (Isoascorbic Acid), Sodium Erythorbate (Sodium Isoascorbate), Sodium Ascorbate, Biostat® PA (Oxytetracycline), Sodium Citrate
DAIRY
Citric Acid, Sodium Citrate, Vitamin A, Sorbistat® (Sorbic Acid), Sorbistat®-K (Potassium Sorbate), Vitamin A Palmitate, Types M & W
OIL & FAT PRODUCTS
Vitamin A & D, Beta Carotene, Citric Acid, Sodium Benzoate
CANNING PRESERVING
Citric Acid, Ascorbic Acid, Sodium Citrate, Calcium Cyclamate, Sodium Benzoate, Tartaric Acid
BEVERAGE
Citric Acid, Ascorbic Acid, Sodium Citrate, Sorbistat®-K (Potassium Sorbate), Calcium Cyclamate, Sodium Benzoate, Tartaric Acid, Caffeine, Erythorbic Acid (Isoascorbic Acid)

Whatever the form or content of tomorrow's foods, they will owe something to the research laboratory of today. If you are working to develop new food products, or to improve present ones, the end to your search may be as close at hand as your Pfizer representative.

The name Pfizer has been synonymous with highest quality ingredients and service for the food industry for more than 110 years. This reputation results, in no small way, from the contributions of Pfizer Technical Service.

Our customers have come to rely on our many products and on our readily available technical service "team" at every stage of product development—from research to finished production.

For example, when manufacturers of "convenience" mixes—general-purpose and specialty baked goods—wanted a more controlled type of leavening action, Pfizer offered Glucono-Delta-Lactone. This chemical leavening acid imparts no unpleasant aftertaste, yet helps provide products having excellent volume and fine even texture. G-D-L's high stability in storage also insures longer shelf life.

Mold and yeast growth had been causing food-freshness problems in cheese, wines, prepared salads, and baked goods. Today, Pfizer Sorbistat®-K and Sorbistat® provide the means to ensure a "stay fresher longer" quality in such products.

In the nutritional area, Pfizer L-LYSINE has made possible great strides in improving the protein quality of grain-based foods ranging from breads to breakfast cereals . . . without affecting the taste or texture of the product. This essential amino acid "activates" the protein potential present, thus improving the total protein quality.

These few examples merely typify Pfizer's experience and willingness to help. Let us prove that our products and personnel can help solve your problems.

If you have a food product problem, look to Pfizer first.

Science for the world's well-being®

Pfizer

CHEMICAL DIVISION

Chas. Pfizer & Co., Inc.
Chemical Division
New York 17, N. Y.

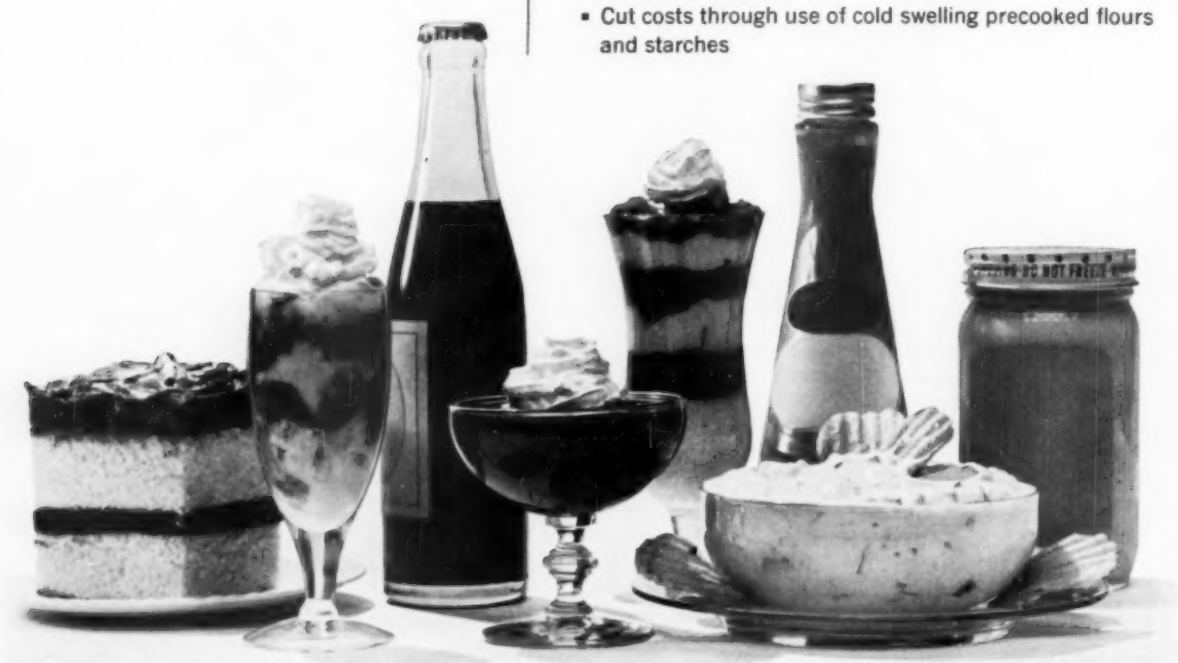
Morningstar-Paisley's

FOOD STARCHES and WATER SOLUBLE GUMS

serving food manufacturers with processed, modified and blended starch and gum products

USE THEM TO—

- Increase water holding ability
- Improve emulsification and suspension
- Enhance texture, color and flavor
- Modify viscosity, improve thickening and binding power
- Improve appearance through greater clarity and smoothness
- Increase resistance to high processing temperatures, even under acid conditions
- Increase shelf life by eliminating "weeping" and adding freeze-thaw stability
- Cut costs through use of cold swelling precooked flours and starches



Write for Product Information Bulletin No. 101.

MORNINGSTAR-PAISLEY, INC.

630 WEST 51st STREET, NEW YORK 19, N. Y.

Cook-up and precooked starches from tapioca, potato, arrowroot. Water soluble gums, stabilizers, emulsifiers.

Offices in 28 principal cities from coast-to-coast. In Canada: Morningstar-Paisley of Canada, Ltd., Toronto

432D

microorganisms may be postulated: a lethal effect; a sublethal effect, which may be reversible or irreversible; and a stimulatory effect. Lethal effects and irreversible sublethal damage would presumably yield the same result so far as viable counts are concerned. Recovery of organisms subjected to reversible sublethal damage would depend on the cultivation procedures used (Straka and Stokes, 1959; Kohn, 1960). Defrosted pathogens have been reported (Gunderson and Rose, 1948; Hartsell, 1951) to be inhibited on several selective media, and found to be more exacting in their nutritive requirements (Straka and Stokes, 1959). In our experiments, counts with defrosted cells of *S. typhimurium* were lower on selective media such as selenite-cystine broth, S-S agar, and brilliant-green agar, than on nonselective complete media. Similar observations were made with frozen cultures of *E. coli* using E. C. broth and eosin methylene-blue agar medium. This is of considerable practical importance, since the use of selective media is customary in evaluating the bacterial content of frozen foods, and this procedure could yield quite misleading results as to the number of viable pathogenic bacteria present.

The transient increase in counts of *S. pyogenes* in FH during the first 40 days at 0°F (Table 1) could be due to the breaking up of chains (Hess, 1934), as a result of freezing, into individual cells and/or shorter chains. The twentyfold increase in the counts of *C. perfringens* during the first two cycles (Table 1) could be due to a stimulating effect of concentration of nutrients during freezing and low-temperature storage (Squires and Hartsell, 1955). It is also possible that cold shock resulted in a more rapid germination of spores, though these forms were not present to any large extent in the cultures used. However, an actual stimulation of the vegetative reproductive mechanisms could have occurred.

No real evidence was obtained concerning the actual mechanism of protection afforded by the sea food to the sensitive bacterial cells. It may be conjectured that the protection is due to the fish protein molecule, which, behaving as a true colloid, might be expected to interfere with the rate of crystallization of water in the foodstuff and subsequently minimize the loss of water from the bacterial cell. The denaturation of bacterial protein might thus be prevented. The extent of protection under such a system would depend to a large extent on the degree of denaturation of the fish protein, and thus its ability to hold bound-water to maintain the equilibrium. Under conditions of multiple thawing and refreezing, considerable damage to the fish-tissue proteins might be expected, resulting in a reduction of their water-binding capacity and a corresponding reduction in their effectiveness as agents protecting bacteria against freezing damage. Such a hypothesis would largely explain the exceptional lethality of multiple freezing processes on bacteria.

Considering the public health significance of the findings of this study, it appears that freezing and cold storage cannot be depended on in all cases to reduce the bacterial loads of foods significantly. In the particular case of sea foods, there may be survival of pathogenic or potentially pathogenic bacteria in numbers sufficient to constitute a hazard to health after long storage in the frozen state, and even after repeated freezing and thawing. For example, 24 cells of *S. typhimurium*, 620 of *S. aureus*, and 1180 of *E. coli* were found in viable state in every ml of FIi even after five cyclic defrostings. It would be unwise, therefore, for food processors to assume that freezing *per se* can be counted on to provide a safety margin against the effects of poor or unsanitary handling. The only sure method of producing bacteriologically safe frozen foods is to ensure that the foodstuff carries few bacteria, and indeed is virtually free of pathogenic bacteria before freezing.

ACKNOWLEDGMENTS

The authors express gratitude to Robert M. Baxter and William J. Wiebe for able technical assistance, and to the Microbiology Department, Medical School, University of Washington, Seattle, for providing some of the cultures used.

REFERENCES

Borgstrom, G. 1955. Microbiological problems of frozen food products. Advances in Food Research **6**, 163.

Cunningham, J., and B. Timothy. 1924. Comparison between the numerical content of certain bacterial suspensions obtained by the Haemocytometer method and Brown's opacity tubes. *Indian J. Med. Research* **11**, 1253.

Frazier, W. C. 1958. Food microbiology. McGraw-Hill Book Co., Inc., N. Y., pp. 113–124.

Gunderson, M. F., and K. D. Rose. 1948. Survival of bacteria in a precooked, fresh-frozen food. *Food Research* **13**, 254.

Haines, R. B. 1937–38. The effect of freezing on bacteria. *Proc. Roy. Soc. (London)*. Ser B, **124**, 451.

Hartsell, S. E. 1951. The longevity and behavior of pathogenic bacteria in frozen foods: the influence of plating medium. *Am. J. Public Health* **41**, 1072.

Hess, E. 1934. The effects of freezing on marine bacteria. I. Quantitative studies. *J. Biol. Board. Canada* **1**, 95.

Hilliard, C. M., and M. A. Davis. 1918. The germicidal action of freezing temperature upon bacteria. *J. Bacteriol.* **3**, 423.

Hilliard, C. M., D. Torossian, and R. P. Stone. 1915. Notes on the factors involved in the germicidal effects of freezing and low temperature. *Science* **42**, 770.

Keith, S. C. 1913. Factors influencing the survival of bacteria at temperatures in the vicinity of the freezing point of water. *Science* **37**, 877.

Kereluk, K., and M. F. Gunderson. 1959. Studies on the bacteriological quality of frozen meat pies. IV. Longevity studies on the coliform bacteria and enterococci at low temperature. *Appl. Microbiol.* **7**, 327.

Kereluk, K., A. C. Peterson, and M. F. Gunderson. 1961. Effect of different temperatures on various bacteria isolated from frozen meat pies. *J. Food Sci.* **26**, 21.

Kohn, A. 1960. Lysis of frozen and thawed cells of *Escherichia coli* by lysozyme, and their conversion into spheroplasts. *J. Bacteriol.* **79**, 697.

Larkin, E. P., W. Litsky, and J. E. Fuller. 1955. Fecal Streptococci in frozen foods. I. A bacteriological survey of some commercially frozen foods. II. Effect of freezing storage on *Escherichia coli* and some fecal streptococci inoculated into green beans. III. Effect of freezing storage on *Escherichia coli* inoculated into orange concentrate. *Appl. Microbiol.* **3**, 98.

Luyet, B. J., and P. M. Gehenio. 1940. The mechanism of injury and death by low temperatures. *Biodynamica* **3**, 33.

Proctor, B. E., and A. W. Phillips. 1948. Frozen precooked foods. *Am. J. Public Health* **38**, 44.

Raj, H., and J. Liston. 1961a. The detection and enumeration of fecal indicator organisms in frozen sea foods. I. *Escherichia coli*. *Appl. Microbiol.* **9**, 171.

Raj, H., and J. Liston. 1961b. The detection and enumeration of fecal indicator organisms in frozen sea foods. II. Enterococci. *Appl. Microbiol.* **9** (4).

Record, B. R., and R. Taylor. 1953. Some factors influencing the survival of *Bacterium coli* on freeze drying. *J. Gen. Microbiol.* **9**, 475.

Smith, A. U., C. Pogle, and J. Smiles. 1951. Microscopic observations of living cells during freezing and thawing. *J. Roy. Microscop. Soc.* **71**, 186.

Squires, R. W., and S. E. Hartsell. 1955. Survival and growth initiation of defrosted *Escherichia coli* as affected by frozen storage menstrua. *Appl. Microbiol.* **3**, 40.

Straka, R. P., and J. L. Stokes. 1959. Metabolic injury to bacteria at low temperatures. *J. Bacteriol.* **78**, 181.

Weiser, R. S., and C. O. Hargiss. 1946. Studies on the death of bacteria at low temperatures. II. The comparative effects of crystallization, vitro-melting and devitrification on the mortality of *Escherichia coli*. *J. Bacteriol.* **52**, 71.

Weiser, R. S., and C. M. Osterud. 1945. Studies on the death of bacteria at low temperatures. I. The influence of the intensity of the freezing temperature, repeated fluctuation of temperature, and the period of exposure to freezing temperature on the mortality of *Escherichia coli*. *J. Bacteriol.* **50**, 413.

Woodburn, J. M., and D. H. Strong. 1960. Survival of *Salmonella typhimurium*, *Staphylococcus aureus*, and *Streptococcus faecalis* frozen in simplified food substrates. *Appl. Microbiol.* **8**, 109.

Changes in pH of Some Frozen Foods During Storage

L. van den Berg

(Manuscript received May 10, 1961)

SUMMARY

Changes in the pH of frozen cauliflower, green beans, tomatoes, cod, haddock, and beef were measured during storage at −10° and −18°C to obtain information on the factors that may affect quality. Changes in pH of 0.3 to 2.0 pH units occurred in all products during the first three months of storage. In cauliflower, green beans, and fish samples, the pH decreased initially (at both −10° and −18°C) but returned to the pre-freezing value (6.0–6.5) after 2–3 months. The pH of tomatoes did not change appreciably at −10°C but increased sharply (1.5 pH units) after 20 days at −18°C, and then returned to its initial value (4.0) 10–20 days later. In beef, the pH increased from 5.6 before freezing to 6.0 immediately after freezing, and then remained essentially unchanged. Changes in pH after three months were small in all products.

Although physico-chemical changes in foods during freezing and frozen storage have been mentioned as a possible cause of quality deterioration (Dyer, 1954; Lea and Hawke, 1952; Lovelock, 1957; Rey, 1957), there appears to be little factual evidence on the types of changes taking place. Early studies by Finn (1932) and Harvey (1918) showed appreciable changes in pH and salt concentration during the freezing of muscle and cabbage juice. Recent studies in this laboratory (Tessier and Rose, 1956; van den Berg, 1959; van den Berg and Rose, 1959) have shown that changes are marked in the mineral composition of the unfrozen phase of milk and of salt solutions during freezing and frozen storage, and that some of these changes are associated with significant changes in pH. New types of glass and calomel electrodes suitable for measuring the pH of frozen foods were developed later (van den Berg, 1960). These electrodes have been used in pH measurements in a variety of frozen foods to obtain information about some of the changes in composition of the unfrozen phase of frozen foods and to study the relation, if any, between these changes and quality deterioration. This paper reports results obtained with some types of vegetables and fish and with beef.

Paper presented at the Twenty-first Annual Meeting of the Institute of Food Technologists, New York, May 7–11, 1961.

Contribution from the Division of Applied Biology, National Research Council, Ottawa 2, Canada. Issued as N.R.C. No. 6493.

EXPERIMENTAL

Fresh foods from local markets were processed and frozen immediately. The test foods were green beans, cauliflower, tomatoes, cod, haddock, and beef. The beans, cauliflower, and tomatoes were cleaned, respectively blanched in boiling water for 4, 5, and 13 min (Tressler and Evers, 1947), and cooled. Tomatoes were peeled. The cod and haddock fillets had been kept in ice containing tetracycline hydrochloride ("Aconized") for about 7 days before purchase. The beef, from a local killing plant, was taken from the hindquarters of a well-aged carcass of a young steer. Bones, fatty tissue, tendons, and connective tissue were carefully removed. All test materials were put through a very coarse grinder to facilitate mixing before freezing and sampling during frozen storage without disrupting most of the cells. The mixed material was frozen in 1-qt tin cans in well-circulated air at −10°C for storage at −10°C, and at −18°C for storage at −18°C (2 or 3 cans at each temperature).

Samples for pH measurement were removed by scraping the frozen surface; the top layer was always discarded because of possible surface desiccation. The measurements were made at the storage temperature with modified glass and calomel electrodes suitable for use at temperatures as low as −25°C (van den Berg, 1960). The glass electrode was somewhat different than described previously in that its pH-sensitive glass bulb was internally coated with low-melting (approx 85°C) Wood's metal and filled with a commercial electrode cement, rather than with mercury only. Breakage of electrodes was considerably reduced without affecting accuracy of measurement.

Phosphate buffers of pH 5.8 and 7.0 containing glycerol to prevent freezing were used for standardizing the electrode at the storage temperature, and measurements were made with a Beckman Model G pH meter. A small amount (10–20 g) of the sample was packed around the tips of the electrodes. Measurements were usually made on samples from two cans at the same time. The results obtained with cod were from two lots of fillets, purchased separately. With most samples, measurements were continued for one year.

Chemical analyses were made on samples of fresh material to study the relation between pH changes and composition. The moisture content was determined directly by freeze-drying followed by drying in vacuum over sulfuric acid, whereas the sodium, potassium, calcium, magnesium, phosphate, chloride, lactate, and citrate contents were determined in trichloracetic acid extracts. The extracts were obtained by shaking about 20 g of sample with glass beads for 20 min with 40 ml of water, and then for another 20 min after addition of 40 ml of 20% (wt) trichloroacetic acid. The resulting suspensions were held 3 hr or more at 2–5°C before filtering, and analyses were then made on the clear filtrate. Sodium and potassium were determined by flame photometry, the phosphate content according to Polley (1949), and the calcium, magnesium, and citrate contents by the methods of Marier and Boulet (1956, 1958, 1959). The lactate content was determined by the method of Barker and Summerson (1941), with a slight modification (Marier, 1960).

RESULTS

The effect of storage time and temperature on pH is shown in Figs. 1 and 2. The general shape of the pH curves was similar for the products with a low acid content (green beans, cauliflower, cod, and haddock) in that pH decreased to a minimum value in early storage, but returned to about the prefreezing value during continued storage. In beef and tomatoes, which contained appreciable amounts of acids (Table 1), the the initial pH decrease was small or absent and most curves had distinct peaks rather than minima. The magnitude of the pH changes was appreciably larger in the vegetables than in fish and beef, presumably because of the large differences in protein content, and hence in buffer capacity. Except in tomatoes and one of the cod samples, the effect of storage temperature on pH was small and varied with the product. Changes in pH in vegetables after 2–3 months and in fish and beef after 6 months were small (0.2–0.3 units), and took place slowly. There were differences between the two samples of cod stored at −18°C; these differences could not readily be explained, although they might have been due to differences in protein buffering capacity, which are not noticeable at −10°C. Differences in pH values between different cans of the same material were relatively small, except where changes in pH were large.

Measurements of pH of beef at several temperatures during the freezing process showed that pH decreased slightly in the range 0 to −5°C and increased 0.3 to 0.4 pH units between −5 and −10°C (Fig. 3). These results confirmed findings of Finn (1932) with ox muscle juice. The changes in pH during freezing were not appreciably affected by rate of cooling (between 0.1 and 5°C per hour). These pH changes were presumably caused by the increase in concentration of salts and proteins in the liquid phase that resulted from withdrawal of water in the form of ice, rather than caused by salt precipitation. Measurements of changes in pH of a solution of potassium phosphate and lactic acid (with pH and concentrations similar to those in beef) during freezing showed that a decrease in pH of 0.2 unit in the range −1 to −5°C was largely due to the effect of ice formation on salt concentration.

DISCUSSION

The results show that pH changes take place continually in frozen foods, even during long periods of frozen storage. Since the pH depends on several physico-chemical factors (buffer capacity, ionic composition, etc.), physico-chemical changes other than pH must also occur at the same time. These other physico-chemical changes have not been analyzed directly, and hence can only be conjectured from results obtained in milk (Tessier and Rose, 1956) and salt solutions (van den Berg, 1959; van den Berg and Rose, 1959) and from known solubility data.

Changes in pH during freezing and subsequent storage may be caused by the increase in concentration of soluble material in the liquid phase as a direct consequence of ice formation, by the subsequent precipitation of salts (van den Berg, 1959; van den Berg and Rose, 1959), and probably by the interaction of proteins with ionic substances in the unfrozen phase of frozen foods. Precipitation of salts would appear to be the cause of large pH changes. The rate of precipitation of salts, however, is slow, presumably because the liquid phase is distributed through the ice mass in small pockets and channels, and the viscosity of the liquid phase is very high due to the high protein and solids contents (van den Berg, 1961). Also, the exchange of ions between proteins and solution may affect salt precipitation. The rate of salt precipitation in the ground material as used in our study may have been somewhat different from the rate of salt precipitation which would occur in material frozen without grinding, because of the disrupted cell walls and the mixing of tissues of different composition.

The similarity in pH curves of green beans, cauliflower, cod, haddock, and milk (van den Berg, 1961) suggests that the same processes and salts are involved in the pH changes for the most part. Precipitation of alkaline calcium, magnesium, and sodium phosphates

Table 1. Composition of food samples used in pH study (% of fresh weight soluble in 10% trichloroacetic acid).

Product	pH at 25°C	H_2O	K	Na	Ca	Mg	Cl	P	Lactic acid	Citric acid
Green beans	5.8	93.2	0.205	0.025	0.034	.....	0.01[a]	0.019	.....	.....
Cauliflower	6.2	92.4	0.245	0.007	0.023	.....	0.03[a]	0.046	.....	.....
Tomatoes	4.0	93.8	0.250	0.004	0.015	0.005	0.1[a]	0.018	.....	0.52
Cod I	6.5	81.0	0.430	0.060	0.011	0.004	0.15	0.17	0.34	.....
Cod II	6.5	.....	0.435	0.094	0.019	0.002	.....	0.17	0.35	.....
Haddock	6.3	80.1	0.365	0.055	0.030	.....	0.15	0.18	.....	.....
Beef	5.6	74.3	0.375	0.050	0.003	0.004	0.06[a]	0.15	0.51	.....

[a] Literature values (McCance and Widdowson, 1940; Winton and Winton, 1935).

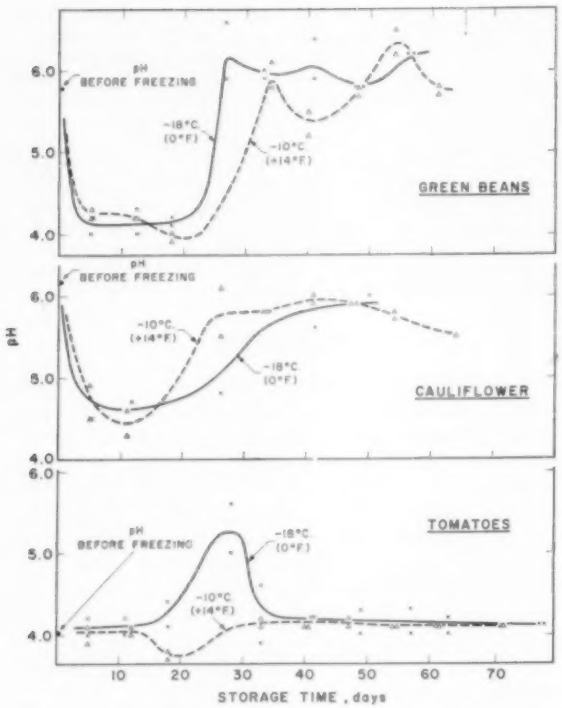


Fig. 1. The effect of storage time and temperature on the pH of frozen green beans, cauliflower, and tomatoes.

is most probably associated with the first pH decrease during storage. Precipitation of acid potassium phosphate and sodium and potassium citrate (these salts are more soluble than the alkaline phosphates) may be responsible for the subsequent large pH increase. Precipitation of minor components and readjustment between the protein and liquid phases would account

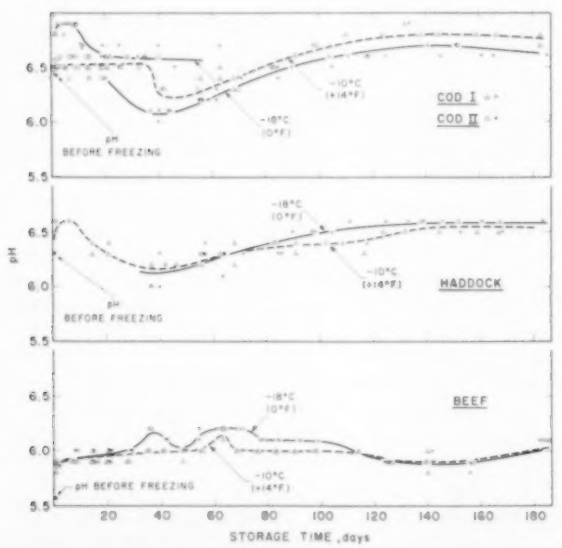


Fig. 2. The effect of storage time and temperature on the pH of frozen cod, haddock, and beef.

for the smaller pH changes during longer storage. The sequence of precipitation of alkaline and acid salts in beef at −10° and −18°C and in tomatoes at −18°C appears to be the reverse of that in the other products, in that the acid salts precipitate first because of the low initial pH. This raises the pH, allowing appreciable amounts of alkaline salts to precipitate.

The magnitude of the pH changes in the products tested appears to be controlled mainly by the buffer capacity of proteins and very soluble salts and the content of very soluble compounds and the less soluble alkaline phosphates mentioned above. The buffer capacity of phosphates, carbonates, and citrates is of little significance because either the acid or the alkaline salt will precipitate during freezing. The pres-

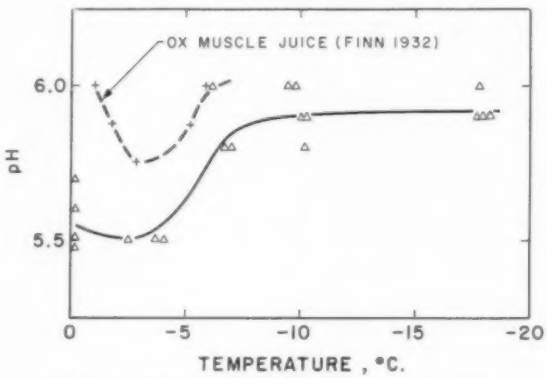
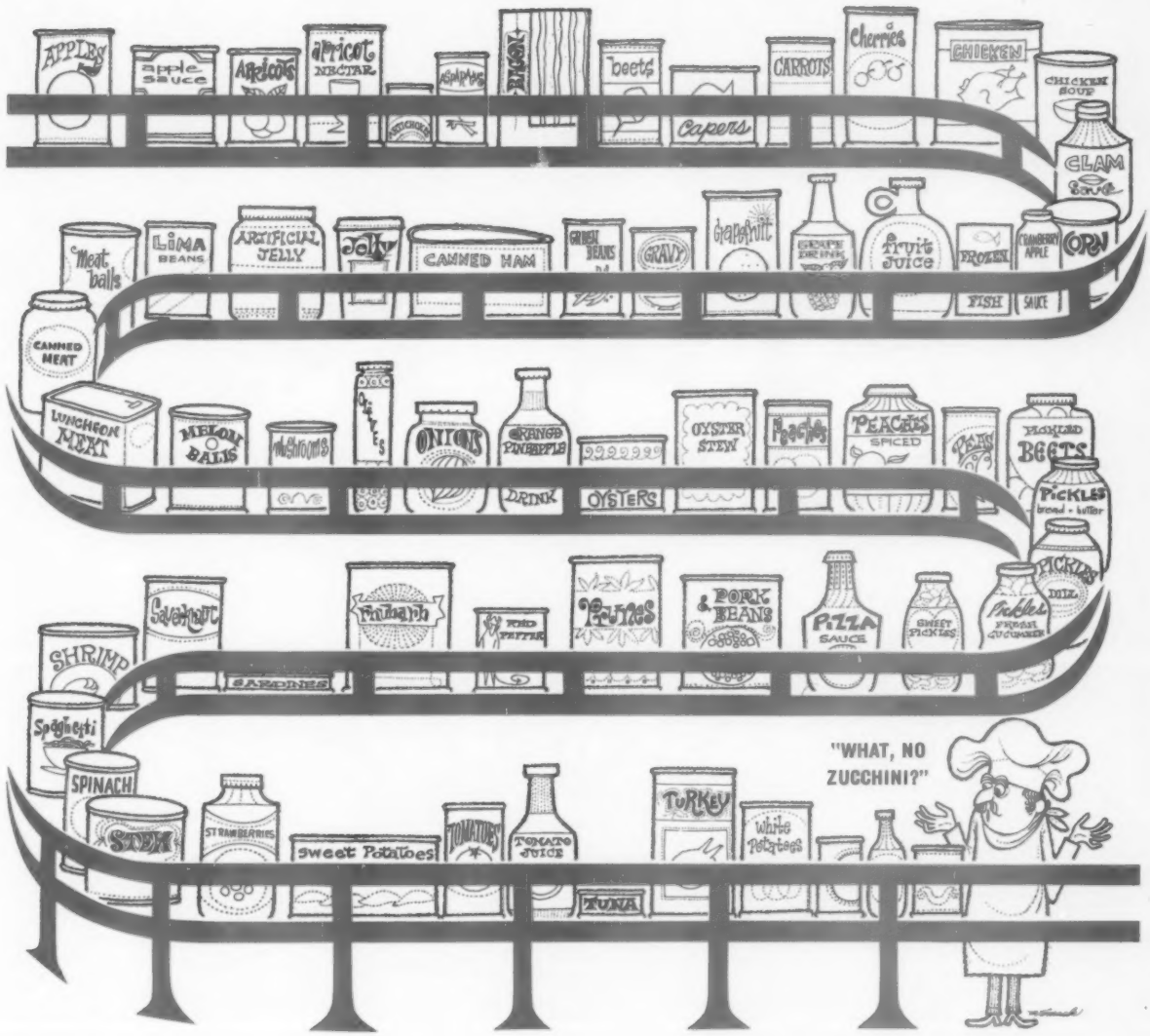


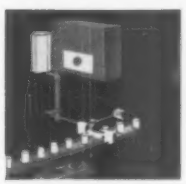
Fig. 3. Changes in the pH of beef during freezing.

ence of very soluble compounds [e.g., lactic acid in fish and beef (Table 1)] decreases the amount of ice formed at each temperature, and hence results in a lower concentration of individual salts in the unfrozen phase. This will reduce the amounts of salts precipitated and may keep the concentration of some salts below the saturation point. The buffer capacity of the system and the amount of alkaline phosphates present (Table 1) determine the magnitude of the initial pH decrease. Since salt precipitation in food is a slow process, and since ice formation in salt solutions usually decreases the pH (van den Berg, 1959; van den Berg and Rose, 1959) it appears that the pH increase during and immediately after freezing (Figs. 2 and 3) is caused at least partially by increasing protein concentration in the liquid phase.

Most of the salts mentioned have eutectic points above −10°C, and hence they tend to precipitate at both storage temperatures (−10° and −18°C), although in different quantities. In addition, the buffer capacity of the unfrozen phase at −18°C is appreciably higher than at −10°C, due to the higher protein content. Therefore, differences in pH due to storage temperature can be expected to be relatively small, except when compounds are present in such quantities that their concentration reaches saturation only below −10°C. This exception appears to be true in tomatoes (and possibly beef), where the pH curve has



NEW MORTON FLOCRON DISPENSER CUTS CANNING COSTS FOR 63 PRODUCTS!

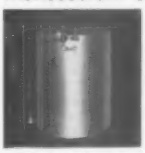


No splash . . . no spill . . . no overfill! Companies who use Morton's amazing Flocron liquid dispenser system to handle any of the 63 different food products listed above report that Flocron avoids the waste inherent in "overflow fill" systems, stops splash loss, and dispenses more than 40 different ingredients with money-saving speed and accuracy.

The versatile Flocron is actually a precise electronic system with photoelectric circuits in a sealed unit and a new lever-type photo switch to activate dispensing. It assures accuracy, even on lines handling up to 300 units per minute! Remote electronic controls permit you to "dial" the exact amount of liquid required for varying can sizes.

Designed for efficient, low cost operation. The Flocron is made of stainless steel and plastic and is constructed to avoid corrosion and lengthy breakdowns that result in costly downtime. There are no valves to stick or clog, and the Flocron is easily cleaned by circulating a detergent solution through the fluid system and following this with a sanitizer. No need to revise production lines. The Flocron can be operated with existing equipment. Scientific Dispensing Company technicians in all areas will assist with installation and servicing.

Some of the liquids you can dispense with the Flocron are: ascorbic acid, beef gravy, brine, concentrated syrup, hot butter, Monosodium Glutamate, spice oils, sugar and brine, tomato puree and vinegar.



MORTON ALSO OFFERS CORROSION-FREE BRINEMAKERS

In addition to the Flocron liquid dispenser, Morton also offers a complete range of Brinemakers, capable of producing up to 800 gals. of saturated pure brine per hour. With the Morton Brinemaker, salt is handled only once at the Brinemaker location from where it may flow or be pumped to the Flocron or other usage points. No space-wasting storage tank needed; no need for costly shut downs for cleaning out impurities.

SCIENTIFIC DISPENSING COMPANY / DIVISION OF

MORTON SALT COMPANY

110 N. Wacker Drive • Chicago, Illinois • FI 6-1300

436A

RASPBERRY

Raspberry has always been the most popular fruit flavor.

Its greatest success depends on the extent of its true reproduction of the flavor of the actual fruit.

Excellent in all types of confectioneries, gelatin and dessert powders.

We invite your inquiries for samples.

VERONA FLAVORS

DEPARTMENT OF VERONA AROMATICS

Plant and Main Office:

26 VERONA AVENUE, NEWARK 4, NEW JERSEY. TEL: HUMBOLDT 3-3200 • NEW YORK: WORTH 2-3153

Branch Office:

208 N. WELLS STREET, ROOM 200, CHICAGO 6, ILL., TEL: CENTRAL 6-5815

VERONA

REGISTERED TRADEMARK

a peak at −18°C but not at −10°C. Considering the factors controlling pH changes, it appears that the small differences in pH due to storage temperatures are associated with large differences in the composition of the unfrozen phase.

Since quality deterioration of foods during frozen storage is markedly dependent on storage temperature in the −10° to −20°C range, and since the differences in pH between samples stored at −10° and −18°C were found to be relatively small, it appears that the relation between pH and quality is not sensitive or direct. The magnitude of the changes in composition of the unfrozen phase that lead to pH changes must be greater than the magnitude of pH changes (buffering capacity), and it may well be that the protein characteristics are affected by composition changes rather than by pH only. It is of interest in this connection that investigations on the drip of frozen meat have indicated that the ion-binding capacities of meat proteins are affected by freezing and frozen storage (Pezacki *et al.*, 1959).

ACKNOWLEDGMENT

The author thanks Miss G. F. Asbury and Mr. G. W. Daechsel for technical assistance.

REFERENCES

Barker, S. B., and W. H. Summerson. 1941. The colorimetric determination of lactic acid in biological material. *J. Biol. Chem.* **138**, 535.

Dyer, W. J. 1954. Main problems of fish protein denaturation. Proc. Symp. Cured and Frozen Fish Technol., Swed. Inst. Food Preserv. Research (SIK)-publ. No. 100.

Finn, D. B. 1932. Denaturation of proteins in muscle juice by freezing. *Proc. Roy. Soc.* London (B) **111**, 39.

Harvey, R. B., 1918. Hardening process in plants and developments from frost injury. *J. Agr. Research* **15**, 83.

Lea, C. H., and J. C. Hawke. 1952. Lipovitellin. 2. The influence of water on the stability of lipovitellin and the effects of freezing and drying. *Biochem. J.* **52**, 105.

Lovelock, J. E., 1957. The denaturation of lipoprotein complexes as a cause of damage by freezing. *Proc. Roy. Soc.* (London) B **147**, 427.

Marier, J. R. 1960. Private communication.

Marier, J. R., and M. A. Boulet. 1956. Direct microdetermination of calcium in milk. *Agr. Food Chem.* **4**, 720.

Marier, J. R., and M. Boulet. 1958–59. Direct determination of citric acid in milk with an improved pyridine-acetic anhydride method. *J. Dairy Sci.* **41**, 1683; **42**, 1885.

Marier, J. R., and M. Boulet. 1959. Turbidimetric microdetermination of magnesium in milk. *J. Dairy Sci.* **42**, 981.

McCance, R. A., and E. M. Widdowson. 1940. The chemical composition of foods. Chem. Publ. Co., New York.

Pezacki, W., B. Cybulko, and S. T. Nawrocki. 1959. Physicochemical properties of boned frozen beef, stored at −16°C. *Proc. Intern. Congr. Refrig., 10th Congr. Copenhagen.*

Polley, J. R. 1949. The micro-colorimetric determination of inorganic phosphate in plasma and urine. *Can. J. Research* E **27**, 265.

Rey, L. R. 1957. Overlook on the biological applications of low temperatures. *Bull. Intern. Inst. Refrig.* **37**, 1115.

Tessier, H., and D. Rose. 1956. Composition of the liquid portion of frozen milk. *Can. J. Technol.* **32**, 211.

Tressler, D. K., and C. F. Evers. 1947. The freezing preservation of foods, 2nd ed. Avi Publishing Co. Inc., New York.

van den Berg, L. 1959. The effect of addition of sodium and potassium chloride to the reciprocal system: KH_2PO_4–Na_2HPO_4–H_2O on pH and composition during freezing. *Arch. Biochem. Biophys.* **84**, 305.

van den Berg, L. 1960. pH measurement at low temperatures using modified calomel and glass electrodes. *Anal. Chem.* **32**, 628.

van den Berg, L. 1961. Changes in pH of milk during freezing and frozen storage. *J. Dairy Sci.* **14**, 26.

van den Berg, L., and Dyson Rose. 1959. Effect of freezing on the pH and composition of sodium and potassium phosphate solutions: the reciprocal system KH_2PO_4–Na_2HPO_4–H_2O. *Arch. Biochem. Biophys.* **81**, 319.

Winton, A. L., and K. B. Winton. 1935. The structure and composition of foods. John Wiley & Sons, Inc., New York.

Maple Sirup. XX.

Conversion of "Buddy" Maple Sap into Normal Maple Sirup

A. E. Wasserman and
C. O. Willits
Eastern Regional Research Laboratory,[a]
Philadelphia 18, Pennsylvania

(Manuscript received July 7, 1961)

SUMMARY

Maple sirup produced from "buddy" sap has a disagreeable odor and flavor and does not meet specifications of the U. S. Department of Agriculture for maple sirup. Inoculation of buddy sap with *Pseudomonas geniculata*, strain 4, and incubation for 1 day at 23°C or 3 days at 3°C results in a sirup with typical maple flavor and no "buddy" off-flavors. Sirup made from the sap fermented with *Pseudomonas geniculata*, strain 4, is dark amber in color.

"BUDDY" MAPLE SIRUP has a characteristic unpleasant flavor that makes it unpalatable and unfit for table sirup by Federal and State specifications (Willits, 1958). The buddy sirup is made from buddy maple sap, but is not the result of improper processing. The undesirable qualities, however, are developed during the boiling and concentrating procedures since buddy sap has no particularly identifiable odor or flavor in itself.

The cause of buddy sap is not known, although several theories have been offered by maple producers. Since buddy sap usually occurs toward the end of the maple sap season, it has been suggested that (a) there is a change in the composition of the sap related to physiological changes taking place in the tree as it comes out of dormancy, a condition usually accompanied by noticeable swelling of the leaf buds, hence the term buddy sap; or (b) the change is in some way caused by the heavy growth of bacteria (Edson, 1910) that occurs when practices are not sanitary. The latter theory has been disproved. Holgate (1948) stated that buddy sap occurred even when the sap had been collected aseptically and was free of bacterial growth. There are no chemical or physical tests for buddy sap, and it cannot be detected until the sap is boiled and partially concentrated. The characteristic odor becomes noticeable in the vapor of the boiling sap.

A sugar bush may contain some maple trees that are "early leafers," i.e., they come out of dormancy before the other trees. "Early leafers" may occur because of natural variation in tree physiology, or they may be the result of different growth conditions within the bush. The "buddiness" of the sap from these trees is usually not suspected, and the sap may be pooled with large quantities of normal sap. The intensity of the characteristic buddy flavor is so great that the sap from one "buddy" tree can render worthless all the sirup from an entire bush. At other times, mild weather in mid-maple season may cause sufficient changes in all the trees to produce only buddy sap, resulting in serious economic losses.

The fixed costs of maple sirup production are covered by the early sap runs of the season. Profits from this crop are usually made from the mid- and late-season sap runs. Therefore, any treatment salvaging the buddy sap would increase the net returns of maple sirup production.

This paper describes a method of treating buddy sap to obtain a sirup that possesses the characteristic maple flavor and is free of buddy odor and flavor.

MATERIALS AND METHODS

Material. Maple sap was obtained aseptically as previously described (Naghski and Willits, 1955). The buddy condition of the sap was determined by boiling a small volume and observing the odor—and flavor when necessary. Fresh sap was used in most of the studies, but several experiments were carried out with sap collected aseptically during previous maple seasons and held frozen at −18°C in sterile one-gallon metal cans. When the frozen sap was to be used the sap was thawed at room temperature for about 18 hr. Before the cans were opened, 95% ethyl alcohol was poured on the tops and spouts and ignited, thus reducing contamination during transfer of the sap to sterile carboys.

Culture. The organism used in these studies is *Pseudomonas geniculata*, strain 4, previously described (Naghski and Willits, 1955) by this Laboratory as having strong maple-flavor-inducing properties when grown in maple sap. The organism was grown in a Brunswick fermenter, with aeration, on a medium composed of: $MgSO_4$, 0.1%; NaCl, 0.1%; KCl, 0.05%; KH_2PO_4, 0.1%; Na_2HPO_4, 0.2%; yeast extract, 0.5%; glucose, 1%. After 24 or 48 hours of growth at 22°C the cells were collected in the centrifuge and resuspended in a small quantity of sterile water.

Procedure. Eight gallons of sap were transferred to each of two 12-gallon carboys. The sap in each carboy was inoculated with a volume of the suspension of *Pseudomonas geniculata* sufficient to give an initial count of 2 or 3×10^6 organisms/ml of sap. One carboy was incubated at room temperature (about 23°C) and the other at about 3°C.

Immediately after the sap was seeded, and after 24 and 72 hours of growth at room temperature, two gallons of sap were removed and converted into maple sirup by standard procedures previously described (Naghski *et al.*, 1957). Samples from the carboy stored at 3°C were removed immediately after seeding, and after 3, 6, and 9 days of incubation, and the sample saps were immediately converted into sirup. The sirups were evaluated by an experienced taste panel.

Color of the sirups was estimated by using color standards for maple sirup established by the U. S. Department of Agriculture. The invert sugar was determined as described (Naghski *et al.*, 1955).

RESULTS AND DISCUSSION

Sirup made from buddy sap prior to fermentation with *Pseudomonas* may have varying degrees of buddiness, ranging from a mild off-flavor to a strong,

[a] Eastern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

characteristic odor that does not have to be confirmed by tasting. However, after 24 hours of incubating the sap with the organisms at room temperature, the buddy flavor can no longer be detected in the sirup made from such a sap and maple flavor is present in varying degrees. Since, normally, the temperature at which maple sap is collected is about 1–5°C, the second carboy was incubated at about 3°C to determine whether the bacterial action on the sap at this temperature would also prevent the buddy flavor from occurring in the sirup. After three days of growth, the sap was made to a sirup in which the buddy flavor was missing and maple flavor was distinguishable. These results are shown in Table 1.

The longer incubation at the lower temperature leads to greater risks of contaminating the sap, and sirups have been made that were "stringy," undoubtedly from the action of contaminating bacteria capable of producing polymerized sugars and gums.

The color of the maple sirups became darker as fermentation progressed. The unfermented saps yielded sirups lighter than light amber (U. S. fancy grade), but after 24 hours' exposure to bacterial action at room temperature, or six days at 3°C, the color of the sirups was darker than dark amber (commercial grade).

Although the dark color produced by the growth of the *Pseudomonas* reduces the economic value of the maple sirup, this process does allow the recovery, and conversion into commercial maple sirup, of buddy sap that would normally be rejected on the market (a total loss of both sap and processing costs). It is possible, therefore, to continue collecting sap after the time when buddy conditions would usually cause a shut-down of operations, thus increasing the crop from a stand of maple trees.

Table 1. Evaluation of "buddy" maple sirups incubated with *Pseudomonas geniculata*, strain 4.

Sample	Incubation		Percent invert	Color of sirup[a]	Flavor of sirup
	Days	°C			
1	0	3	<2	<1	Buddy
2	3	3	>2 <4	2	Not buddy; some maple
3	6	3	>3 <5	>3	Maple
4	9	3	>4 <6	>3	Maple
5	0	23	<2	<1	Buddy
6	1	23	>2 <4	>3	Not buddy; some maple
7	3	23	>5 <6	>3	Maple

[a] U. S. Department of Agriculture color standards for maple sirup: 1 = light amber; 2 = medium amber; 3 = dark amber.

The mode of action of the bacteria in converting the components of buddy sap so the buddy flavor and odor are not produced is not known. However, since it has been shown that maple sap increases in nitrogen content as the season progresses, it is possible that the metabolism of this nitrogen removes the source of the undesirable components and allows the normal maple flavor to develop.

Although only *Pseudomonas geniculata*, strain 4, was used in this study, there is no reason to doubt that practically all bacteria capable of growth on maple sap with the resultant production of good maple-flavored sirup will be able to convert the buddy sap into maple sirup. However, strains of bacteria that impart off flavors and colors to maple sirup as a result of growth in normal maple sap will probably not improve the flavor of sirup by growth in the buddy sap.

REFERENCES

Edson, H. A. 1910. Buddy sap. *Vermont Univ. Agr. Expt. Sta. Bull.* **151**, 484.

Holgate, K. C. 1948. Sterile maple sap prolongs yield, protects quality. *Canner* **27**.

Naghski, J., and C. O. Willits. 1955. Maple sirup. IX. Microorganisms as a cause of premature stoppage of sap flow from maple tap holes. *Appl. Microbiol.* **3**, 149.

Naghski, J., C. O. Willits, and W. L. Porter. 1955. A simple and rapid test for the analysis of maple sirup for invert sugar. *Food Research* **20**, 138.

Naghski, J., L. L. Reed, and C. O. Willits. 1957. Maple sirup. X. Effect of controlled fermentation of maple sirup on the color and flavor of maple sirup. *Food Research* **22**, 176.

Willits, C. O. 1958. Maple sirup producers manual. *U. S. Dept. Agr., Agr. Handbook* 134.

Changes in Some Volatile Constituents of the Banana During Ripening, Storage, and Processing

H. O. Hultin [a] **and B. E. Proctor**
Department of Nutrition, Food Science and Technology, Massachusetts Institute of Technology, Cambridge, Mass.

(Manuscript received April 7, 1961)

SUMMARY

Some of the volatile constituents of the banana were identified from an aqueous distillate. The compounds identified were acetic acid, methyl alcohol, ethyl alcohol, methyl acetate, ethyl acetate, 2-hexenal, 2-pentanone, and, tentatively, isoamyl alcohol, isoamyl acetate, and 2-octanone. The changes in concentrations of these components during ripening, storage, and processing of the fruit were determined. The importance of these changes as regards banana odor has been evaluated, and possible explanations for some of these changes are discussed.

MUCH WORK has been done on the volatile constituents of some fruits (Coppens and Hoejenbos, 1939a, b; Dimock and Corse, 1958; Haagen-Smit *et al.*, 1945, 1949; Holley *et al.*, 1955; Huelin, 1952; Kirchner and Miller, 1953, 1957; Kirchner *et al.*, 1953; McGlumphy, 1951; Webb and Kepner, 1957; White, 1950; Winter *et al.*, 1958), but there is very little information of this type for bananas. Rothenbach and Eberlein (1905) found in a steam distillate of banana, amyl acetate, amyl isovalerate, and an ethyl ester, which were identified chiefly by their odors before and after saponification. Kleber (1912) identified amyl acetate as a normal constituent of the ripe banana by steam distillation of banana pulp, and saponification and oxidation of the distillate followed by analysis of the acid salt produced on treatment with silver nitrate.

The pulp of ripe lacatan bananas was reported by von Loesecke (1950) to contain the amyl esters of acetic and butyric acids, appreciable amounts of acetaldehyde, and very small quantities of ethyl and methyl alcohols; but they gave no details on the experimental procedures used. The essential oil of the fruit, prepared by an ethyl ether extraction of a concentrated pulp distillate, was a yellow viscous oil amounting to 0.0013% by weight of the fresh pulp.

A number of methods have been used to isolate and identify the volatile constituents of foods (Coppens and Hoejenbos, 1939a; Dimock and Corse, 1956; Haagen-Smit *et al.*, 1945; Kirchner, 1949; Stahl, 1957; Winter *et al.*, 1958). The method of separation of the volatiles is critical, since different methods give differences in chemical composition, organoleptic properties, and yield (Spencer and Stanley, 1954). Therefore it is desirable to use as mild a method as possible to avoid unnecessary deleterious changes in the volatile constituents. Holley *et al.* (1955) identified the volatile constituents of Concord grape juice from a dilute aqueous solution, thus avoiding the relatively harsh treatments necessary with most techniques for separating the volatile compounds from the aqueous phase.

Studies of the effect of ripening, storage, and processing on nonvolatile constituents of foodstuffs have been relatively extensive (Dame *et al.*, 1956; McCready and McComb, 1954; Postlmayr *et al.*, 1956; Steward, 1955; von Loesecke, 1950; Woodmansee *et al.*, 1959), but the effect of ripening, etc., on the volatile constituents of food materials has received little attention. Serini (1956) reported that the amount of acetylmethylcarbinol in the banana increases progressively during the ripening period, while 2,3-butylene glycol reaches a maximum at the onset of overripeness and then decreases. Luh *et al.* (1955) studied the influence of the ripeness of fresh Bartlett pears on the quantity of various volatile reducing substances in the canned product.

This study was undertaken to determine some of the volatile constituents of the banana and the effect that ripening, storage, and processing have on these constituents.

MATERIALS AND METHODS

Sample description. All banana samples used were prepared and supplied through the courtesy of Mr. George L. Poland, United Fruit Company, Boston, Massachusetts. They are described as follows:

1) *Green.* Eight fingers of all-green fruit were taken for examination. No sugar values were measured; fruit at this stage of ripeness usually contains less than 2% total sugars.

2) *Half-ripe.* Eight fingers of fruit were taken after ripening at 68°F until the skin color had begun to turn from green to yellow (skin color was about half green and half yellow). When this skin color was reached, the bananas were placed in a well-ventilated room at 56°F to retard further ripening. Fruit at this ripeness stage usually contains 3–7% total sugars.

3) *Ripe.* Fifteen fingers were selected after ripening at 68°F with adequate ventilation for 4 days. At that time the skin color of the bananas was almost completely yellow with some slight green coloring at the tips. There were no brown flecks. The sugar content was 12.3% total sugars.

4) *Ethylene-ripened.* The ripening of some fruits may be hastened with ethylene gas. The effect of this gas on the ripening of bananas has been reviewed by von Loesecke (1950). The fruit was ripened 3 days at 68°F with ethylene stimulation. Then the ripening room was vented, the temperature lowered to 58°F for the fourth day, and fifteen fingers were then selected for examination. Skin color was essentially the same as that of ripe fruit, and total sugar content was 12.6%.

5) *Scalded.* "Scald," or "gas injury," is exhibited by some fruits during ripening, and in bananas scald has the effect of producing small brown specks in the peel. A tendency for the peel to bruise or turn brown at very slight physical contact accompanies this symptom, and the pulp of scalded fruit develops an unpleasant off-odor. Scalding of bananas is

[a] Present address: Department of Food Technology, University of Massachusetts, Amherst, Massachusetts.

Contribution Number 422 from the Department of Nutrition, Food Science and Technology.

associated with an accumulation of carbon dioxide in the surrounding atmosphere to a concentration greater than 10%. Scalded fruit was produced by ripening the bananas at 68°F with ethylene stimulation for four days in a relatively gas-tight room; at the end of this time the level of carbon dioxide in the atmosphere was 10.5%. Scald developed within 24 hr of removal of the fruit from the ripening room. The total sugar content of this fruit was 14.7% and its skin color was similar to that of the ripe sample, with slightly less green. Seventeen fingers were selected for examination.

6) *Overripe.* This was the same fruit as the ripe sample except that it was allowed to ripen further at room temperature until the skin had large brown blotches.

7) *Coated.* Ten fingers of the banana fruit were coated with a mixture of acetylated monoglycerides by a 3-sec dip treatment, followed by draining. This coating causes "suffocation," because there is no longer a free exchange of gases through the peel. The coated fruit was held 4 days at 56°F; no ripening occurred at this temperature. It was originally intended to coat the bananas with a wax, or similar substance, to prevent mechanical damage during shipment. However, undesirable odors and flavors are developed in fruit treated in this manner. Therefore, it was useful to determine the effect this treatment had on the detectable volatile chemical constituents of the banana.

8) *Coated control.* This fruit was handled in a manner similar to that of the coated fruit but without the dip treatment. The skin color of both the coated and coated control was yellow with green tips.

9) *Gros Michel puree.* The canned banana puree was commercially prepared according to the method of Northcutt and Gemmill (1957), by a high-temperature short-time process. As with all the fresh samples, the variety of banana used in the processing of this puree was Gros Michel, the common commercial variety. The skin color of these processed bananas was yellow, heavily flecked with brown. The puree contained about 19% total sugars.

10) *Lacatan puree.* Lacatan bananas were used in the preparation of this puree instead of the Gros Michel variety; otherwise, the products were similar. The lacatan is of interest because of its resistance to fungal disease. Lacatan bananas have a very fine flavor but do not transport well, thus making them ideal for processing in the areas where they are grown.

Preparation of volatile distillate. A low-temperature high-vacuum method of distillation was used. The bananas were peeled, and the pulp was ground with mortar and pestle. One hundred fifty g of the thoroughly mixed sample was then removed and further ground with sand to macerate the cells fully. The ground sample was immediately transferred to a 1-L round-bottom flask and swirled in a dry ice-ethanol bath until frozen. (This procedure should be carried out as rapidly as possible to prevent deleterious changes.) The air in the flask was replaced by nitrogen, and the flask tightly stoppered. The frozen sample was thawed at room temperature and refrozen to rupture the cells further. The sample was then distilled at a pressure of 1 mm Hg and the volatile material condensed in a trap immersed in a dry ice-ethanol bath. Previous work, with a liquid nitrogen trap placed after the dry ice-ethanol trap, showed the latter to be adequate in trapping the volatiles. After the distillation was completed, the aqueous distillate was removed from the trap and thawed, and aliquots were immediately removed for the various analytical procedures described below.

Identification of alcohols. The alcohols present in the distillate were converted to their 3,5-dinitrobenzoate derivatives by the method of Holley and Holley (1952). The alcohol derivatives were separated by paper chromatography on Whatman No. 1 filter paper using a solvent system of heptane-methanol (Meigh, 1952a) or 30% aqueous pyridine (Rice *et al.*, 1951). The spots were developed with a 5% solution of α-naphthylamine in 95% ethanol (Rice *et al.*, 1951).

Methanol and ethanol were identified by the R_F values of their 3,5-dinitrobenzoate derivatives on paper, by the melting points and mixed melting points of their derivatives with pure known derivatives, and by cochromatography with known derivatives. Material for melting-point determinations was obtained by cutting out the spots separated on paper without spraying with the chromagen. The derivatives were then eluted from the paper with absolute ethanol, dried under vacuum, dissolved in chloroform, and filtered. They were again dried, and finally recrystallized from aqueous ethanol. One of the derivatives gave a product that had a melting point of 106.5–107°C, uncorrected. The pure derivative of methanol had the same melting point, and a mixed melting point showed no depression. The other substance had a melting point of 92–93°C, uncorrected. The 3,5-dinitrobenzoate of ethanol melted at 92.5–93°C, and when the unknown was mixed with it there was no melting-point depression. Isoamyl alcohol was tentatively identified by the R_F values of its derivative on paper in the heptane-methanol and aqueous pyridine systems. Attempts failed to obtain a pure crystalline derivative with the quantities used.

The alcohols of the aqueous distillate were estimated semi-quantitatively by comparing the size and intensity of the developed spots of the 3,5-dinitrobenzoate derivatives with those of pure derivatives of known concentrations.

Identification of acids. The volatile acids in the distillate were separated and identified by the R_F values of the ammonium salts by paper chromatography with a solvent system of *n*-propanol-concentrated aqueous ammonia (Isherwood and Hanes, 1953) and developing the spots with bromcresol green (Lugg and Overell, 1947), and by the retention volume of the free acids as determined by column partition chromatography on silicic acid according to the method of Marvel and Rands (1950).

Acetic acid was the only free volatile acid found in the distillate. Quantitative determination of the acid was done by titration with standard base after separation on the silicic acid column. Recovery experiments with known amounts of acetic acid were performed to test the efficiency of the procedure.

Titratable acidity. The titratable acidity of the aqueous distillate was determined by titration with a standard base. Within experimental error the amount of acid found was equivalent to the acetic acid as determined above, indicating that acetic acid was certainly the major volatile acid of the banana distillate.

Identification of alcohol components of esters. The free alcohols were first removed by oxidation with atmospheric oxygen in the presence of the catalyst, powdered platinum (Holley *et al.*, 1955). The esters were then saponified with sodium hydroxide at room temperature (Mallick *et al.*, 1959), and the alcohols determined as the 3,5-dinitrobenzoate derivatives, as described above. Ethyl, methyl, and (tentatively) isoamyl alcohol were identified.

Identification of acid components of esters. The organic acids were determined before and after saponification, as described above. Acetic acid was the only acid found in the volatile-ester fraction. The esters identified were, therefore, ethyl, methyl, and isoamyl acetate. By subtracting the free acetic acid from the total acetic acid after saponification, the amount of acid derived from the esters was obtained.

Identification of carbonyl compounds. The carbonyl compounds were precipitated from the aqueous distillate as the 2,4-dinitrophenylhydrazone derivatives. Ten ml of the distillate were mixed with 10 ml of a 0.4% solution of 2,4-dinitrophenylhydrazine in 2*N* hydrochloric acid, and the mixture was allowed to stand for 3 hr at 0°C. The hydrazones were then filtered, washed with water, and eluted from the filter paper with petroleum ether-benzene (1:1 v/v). The filtrate was extracted with hexane, and the two solutions were then combined and dried under vacuum. All solvents used in these determinations were first distilled over 2,4-dinitrophenylhydrazine. The crude derivative mixture was investigated by paper chromatography on Whatman No. 1 filter paper with four different solvent systems: heptane-methanol (Meigh, 1952b), ethanol-petroleum ether (4:1 v/v) (Block *et al.*, 1955), 5% ethyl ether in petroleum ether (Rothenbach and Eberlein, 1905), and *n*-butanol-water (Block *et al.*, 1955).

2-Hexenal and 2-pentanone were identified by the R_F values of their 2,4-dinitrophenylhydrazone derivatives on paper, by

the melting points and mixed melting points of these derivatives with pure known derivatives, by cochromatography with known derivatives, and by the ultraviolet spectra of the derivatives. Material for melting-point determinations was obtained by eluting the derivatives from the paper with hot ethanol, evaporating the solvent, dissolving the derivatives in petroleum ether-benzene, filtering, evaporating, and recrystallizing from aqueous ethanol (Wiseblatt and Kohn, 1960). One of the 2,4-dinitrophenylhydrazones had a melting point of 144.5–145°C, uncorrected. This was identical to that of the pure derivative of 2-hexenal, and mixing the two gave no change in melting point. The other 2,4-dinitrophenylhydrazone had a melting point of 142–143°C, compared to 142.5–143°C for the 2-pentanone derivative. Melting-point was not depressed when the two were mixed. The 2-hexenal derivative had an absorption maximum at 376 mμ, and the derivative of 2-pentanone at 368 mμ; both readings were made in a chloroform solution. 2-Octanone was tentatively identified by the R_F values of its derivative on paper in the four systems, by cochromatography with a pure known derivative, and by its ultraviolet absorption spectrum. The absorption maximum was at 364 mμ in chloroform. Attempts failed to obtain a crystalline product from the crude sample mixture.

The volatile carbonyl compounds were determined quantitatively as their 2,4-dinitrophenylhydrazones by elution of the spots with hot ethanol, evaporation, dissolving in chloroform, and reading their absorption in ultraviolet light at the wavelength of maximum absorption of each derivative (Meigh, 1956). Standard curves were prepared by subjecting pure known derivatives to the same procedure the unknowns received.

RESULTS AND DISCUSSION

Table 1 shows the changes in the identified volatile constituents of banana fruit during ripening. The high content of methyl alcohol in the half-ripe (half-green, half-yellow) fruit could possibly be due to increased pectin esterase activity during this period of maximum respiratory activity. The great increase of ethyl alcohol in the overripe fruit is typical of many plant tissues and is probably due in large part to anaerobic decomposition of sugar. Except for ethyl alcohol and ethyl acetate in the green and half-ripe fruit, the change in each ester of the banana during ripening follows, in general, the same trend as the corresponding alcohol, suggesting that the amount of a particular ester formed might depend on the alcohol content in the tissue.

As the banana ripens, going from green skin color to full yellow to yellow flecked with brown, a delicate aroma is produced that is absent in the unripe fruit. The identified compounds were evaluated organoleptically to determine whether the change in concentration of these substances during ripening affected the organoleptic properties of the banana. In this respect, the carbonyl constituents were the most interesting. When the aqueous distillate was reacted with the 2,4-dinitrophenylhydrazine solution, much of the typical banana odor was lost. 2-Hexenal was the carbonyl present in greatest abundance, and it reached its maximum concentration in the ripe (all-yellow) banana. This substance has been found in a great many plants, including strawberries, apples, grapes, string beans, green tea, mulberry leaves, etc. Nye and Spoehr (1943) observed that this compound is produced in increased quantities in the leaves of *Ailanthus glandulosa* when the leaves are ground in the presence of air for 75 min, as compared to grinding in an inert atmosphere such as nitrogen or carbon dioxide. Winter *et al.* (1958) observed the same phenomenon when they mashed strawberries in air instead of an inert atmosphere. It was concluded, therefore, that 2-hexenal is an artifact and is not actually present in the fruit tissue. At the concentrations found in this study, 2-hexenal definitely contributed to the odor of the banana. In this work the banana samples were ground in air although exposure to air was kept to a very few minutes before the samples were frozen. It is conceivable that the 2-hexenal is produced in a very short time on exposure of the tissues to air, but if this is so, 2-hexenal could be produced in banana pulp while it is being prepared for eating or even while it is being eaten. The change in concentration of 2-hexenal at different stages of ripeness indicates that if this compound is not a normal product of the banana tissue, at least the stage of ripeness of the banana has an effect on the ability of the tissue to produce it, and this ability may have an important effect on the flavor and aroma of the banana as it is eaten. Further work is required to elucidate the method of formation and the function of this compound in the banana, and to determine its contribution to banana flavor under various conditions.

Table 1. Analysis (mg/100 g pulp) of some volatile constituents of Gros Michel banana pulp at different ripeness stages.

Compound	Green	Half-ripe	Ripe[a]	Overripe
Acetic acid	0.26	0.56	0.48	1.57
Methyl alcohol	2.2	18.5	1.5	5.6
Ethyl alcohol	1.1	0.4	0.5	22.6
Isoamyl alcohol[b]	0.3	0.4	0.1	5.6
Methyl acetate	4.5	9.5	1.3	5.0
Ethyl acetate	22.4	9.5	0	16.9
Isoamyl acetate[b]	0.02	0.1	0.02	1.2
2-Hexenal	2.2	4.6	7.6	1.9
2-Pentanone	2.1	1.4	2.7	1.1
2-Octanone[b]	0.3	0.2	0.8	0.8

[a] In the ripe sample, a fourth carbonyl compound was observed. It was present in trace quantities, and no identification was made except to judge, by its R_F values, that it possibly contained about 10 carbon atoms.

[b] Tentative identification.

The only volatile acid identified in the distillate was acetic acid, although Wolf (1958) found formic acid also to be a constituent of banana pulp.

The concentration of esters in the ripe sample was very small, with no ethyl acetate present although this compound was the predominant ester at other ripeness stages of the banana. The concentration of alcohols was also very slight at this ripeness stage. Most of the compounds identified did not contribute directly to a "typical" banana odor, though many were important in producing the background notes. However, like 2-hexenal, isoamyl alcohol was an exception to this, and at the concentrations found in the overripe sample it contributed significantly to the "rank" odor of the overmature fruit as determined by organoleptic evaluation.

The volatile chemical compounds identified in the aqueous banana distillate varied, depending on the ripening procedure used (Table 2). The ripe samples, i.e., the bananas ripened without the use of ethylene or without being allowed to develop scald, had a significantly lower ester content than the ethylene-ripened or scalded (also ethylene-ripened) samples.

Table 2. Analysis (mg/100 g pulp) of some volatile constituents of Gros Michel bananas ripened under different conditions.

Compound	Ripe[a]	Ethylene-ripened[a]	Scalded
Acetic acid	0.48	0.50	0.42
Methyl alcohol	1.5	4.0	5.5
Ethyl alcohol	0.5	1.3	1.1
Isoamyl alcohol[b]	0.1	0.4	0.4
Methyl acetate	1.3	4.0	11.0
Ethyl acetate	0	15.8	11.0
Isoamyl acetate[b]	0.02	0.1	0.7
2-Hexenal	7.6	2.6	7.6
2-Pentanone	2.7	0.6	1.4
2-Octanone[b]	0.8	0.1	0.1

[a] In the ripe and ethylene-ripened samples, a fourth carbonyl compound was observed (Footnote a, Table 1).
[b] Tentative identification.

The actual mechanism by which ethylene hastens the ripening of the banana is unknown. Further work should be performed to elucidate the role of ethylene in influencing volatile-ester production in the banana fruit. The presence of a fourth, unidentified carbonyl component in the aqueous distillate of the ripe and ethylene-ripened, but not the scalded, samples is interesting in view of the organoleptic superiority of these samples over the one allowed to develop scald. It is suggested that this unidentified compound might be of value in developing a high-quality banana odor in the fruit. The variation found in the other components does not appear to be important as regards the odor of the banana.

Table 3 presents the results of the analyses of the identified volatile constituents of the acetylated monoglyceride-coated bananas and their uncoated controls. There was very little difference between these samples as far as any of the identified constituents were concerned. The fact that both these samples were held at 56°F, a temperature at which little metabolic activity occurs, could account for this similarity. The most striking feature of these results is the high concentration of ethyl alcohol in both the coated and uncoated samples. This may have been because the bananas used in this segment of the study came from a different growing area than the other samples, or it may reflect the long holding time (4 days) at a relatively low temperature (56°F) that both the coated and uncoated samples were subjected to. The slightly greater amount of carbonyl compounds in the control fruit than in the coated samples could possibly reflect a difference in oxidation-reduction potentials between the samples, caused by the prevention of a free exchange of gases in the coated fruit. The internal oxygen concentration has been suggested as an important factor in controlling metabolic changes during maturation of the banana (von Loesecke, 1950). In any case, none of the differences observed could account for the tremendous organoleptic differences between these banana samples. The odor and flavor of the coated fruit was extremely unpleasant, making the sample inedible. Presumably, compounds other than those identified are involved.

Table 3. Analysis (mg/100 g pulp) of some volatile constituents of coated and uncoated Gros Michel bananas.

Compound	Coated	Coated control
Acetic acid	0.61	0.46
Methyl alcohol	3.0	3.0
Ethyl alcohol	74.4	89.4
Isoamyl alcohol[a]	0.7	1.5
Methyl acetate	6.0	8.9
Ethyl acetate	11.9	7.4
Isoamyl acetate[a]	0.2	0.2
2-Hexenal	2.5	3.9
2-Pentanone	0.5	1.2
2-Octanone[a]	0.9	1.1

[a] Tentative identification.

Table 4. Analysis (mg/100 g pulp) of some volatile constituents of heat-processed banana purees.

Compound	Gros Michel puree	Lacatan puree[a]
Acetic acid	2.6	2.2
Methyl alcohol	5.9	3.4
Ethyl alcohol	14.6	5.6
Isoamyl alcohol[b]	0.5	0.8
Unknown alcohol[c]	0.2	1.1
Methyl acetate	4.4	0
Ethyl acetate	0	0
Isoamyl acetate[b]	0	0
2-Hexenal	0	0
2-Pentanone	5.8	7.3
2-Octanone[b]	2.0	0.7
Unknown carbonyl[d]	1	1

[a] The lacatan puree contained traces of acetone as determined by R_F values of its 2,4-dinitrophenylhydrazone on paper.
[b] Tentative identification.
[c] The unknown alcohol was tentatively identified as *n*-butyl alcohol by the R_F values of its 3,5-dinitrobenzoate on paper. For quantitative determinations it was compared with the isoamyl alcohol derivative.
[d] By the R_F values of its 2,4-dinitrophenylhydrazone on paper, this compound was shown not to be a simple acyclic saturated monocarbonyl. It was estimated quantitatively by its absorbance at 368 mμ using the standard curve of 2-pentanone.

Table 4 shows the concentrations of the volatiles found in the heat-processed pureed bananas. The volatiles of the two purees, although quite similar with respect to each other, were considerably different from those of the fresh fruit. This is evident even though no samples were available of the fresh fruit that actually went into the purees. 2-Hexenal, the major carbonyl component of fresh banana, was not present in detectable amounts in the purees. The absence of this substance in the canned banana puree is in agreement with the suggested oxidative enzymic process of its formation (Nye and Spoehr, 1943), for if the process is an enzymatic one, the quick mashing and deaeration of the pulp in making the puree would tend to retard the formation of this compound, and the subsequent heat treatment would probably inactivate any enzymes, making further formation of 2-hexenal impossible. Another possible explanation is that 2-hexenal, a fairly unstable substance, decomposes during processing or subsequent storage of the puree.

The ester content of the purees was very low; methyl acetate was the only ester found, and in only one puree. During the processing of the puree it seems probable that, at the elevated temperatures used (Northcutt and Gemmill, 1957), the esters undergo hydrolysis. The greater acetic acid content in purees than in fresh fruit tends to support this explanation.

Two compounds were found in both purees that were not present in any of the fresh fruit samples. One was tentatively identified as a 4-carbon alcohol, and the other was a carbonyl compound of unknown

structure, but it was not a simple acyclic monocarbonyl. The positive identification of these compounds, their precursors in the banana, and their exact role, if any, in modifying the flavor of banana puree from that of fresh fruit, should be investigated further.

Synthetic banana essences were prepared with the compounds identified in the volatile aqueous distillate of the banana. The resulting mixtures were not identical in odor to the natural product; this is, however, the usual situation in a problem such as this (Holley *et al.*, 1955). Nevertheless, there was some similarity between the odors of the synthetic essences and the natural fruit. Although the synthetic essences were patterned after the ripe or overripe samples, their odors were generally thought by the panel members to be more like the odors of green bananas. This may be due to the presence of 2-hexenal, with its "green" or grassy smell (Webb and Kepner, 1957). Further work is obviously required to complete identification of the volatile substances of the banana.

ACKNOWLEDGMENT

This work was supported by a grant from the United Fruit Company, Boston, Massachusetts.

REFERENCES

Block, R. J., E. L. Durrum, and G. Zweig. 1955. *A manual of paper chromatography and paper electrophoresis.* Academic Press, Inc., New York.

Coppens, A., and L. Hoejenbos. 1939a. Investigation of the volatile constituents of raspberry juice (*Rubus idaeus*, L.). *Rec. trav. chim.* **58**, 675.

Coppens, A., and L. Hoejenbos. 1939b. Investigation of the volatile constituents of strawberry juice (*Fragaria eliator* Ehrh.) *Rec. trav. chim.* **58**, 680.

Dame, C., Jr., S. J. Leonard, B. S. Luh, and G. L. Marsh. 1956. The influence of ripeness on the organic acids, sugars, and pectin of canned Bartlett pears. *Food Technol.* **10**, 28.

Dimock, K. P., and J. Corse. 1956. Gas chromatography—a new method for the separation and identification of volatile materials in foods. *Food Technol.* **10**, 360.

Dimock, K. P., and J. Corse, 1958. The volatile flavors of strawberry. *Am. Perfumer Aromat.* **71**, 45.

Haagen-Smit, A. J., J. G. Kirchner, A. N. Prater, and C. L. Deasey. 1945. Chemical studies of pineapple. I. The volatile flavor and odor constituents of pineapple. *J. Am. Chem. Soc.* **67**, 1646.

Haagen-Smit, A. J., F. N. Hirosawa, and T. H. Wang. 1949. Chemical studies on grapes and wines. I. Volatile constituents of Zinfandel grapes (*Vitis vinifera* var. Zinfandel). *Food Research* **14**, 472.

Holley, R. W., and A. D. Holley. 1952. The identification of alcohols in dilute aqueous solution. *Anal. Chem.* **24**, 216.

Holley, R. W., B. Stoyla, and A. D. Holley. 1955. Identification of some volatile constituents of Concord grape juice. *Food Research* **20**, 326.

Huelin, F. E. 1952. Volatile products of apples. III. Identification of aldehydes and ketones. *Australian J. Sci. Research* **5**, 328.

Isherwood, F. A., and C. S. Hanes. 1953. Separation and estimation of organic acids on paper chromatograms. *Biochem. J.* **55**, 824.

Kirchner, J. G. 1949. The chemistry of fruit and vegetable flavors. In *Advances in Food Research.* E. M. Mrak and G. F. Stewart. Vol. II, 259. Academic Press, Inc., New York.

Kirchner, J. G., and J. M. Miller. 1953. Volatile oil constituents of grapefruit juice. *J. Agr. Food Chem.* **1**, 512.

Kirchner, J. G., and J. M. Miller. 1957. Volatile water-soluble and oil constituents of Valencia orange juice. *J. Agr. Food Chem.* **5**, 283.

Kirchner, J. G., J. M. Miller, R. G. Rice, G. J. Keller, and M. M. Fox. 1953. Volatile water-soluble constituents of grapefruit juice. *J. Agr. Food Chem.* **1**, 510.

Kleber, C. 1912. The occurrence of amyl acetate in bananas. *Am. Perfumer* **7**, 235.

Lugg, J. W. H., and B. T. Overell. 1947. Partition chromatography of organic acids on a paper sheet support. *Nature* **160**, 87.

Luh, B. S., S. J. Leonard, D. S. Patel, and L. L. Claypool. 1955. Volatile reducing substances in canned Bartlett pears. *Food Technol.* **9**, 639.

Mallick, A. K., S. N. Mitra, and T. V. Mathew. 1959. Cold process of saponification and its advantages. *J. Inst. Chem. India* **31**, 122.

Marvel, C. S., and R. D. Rands, Jr. 1950. Separation of organic acids. *J. Am. Chem. Soc.* **72**, 2642.

McCready, R. M., and E. A. McComb. 1954. Pectic constituents in ripe and unripe fruit. *Food Research* **19**, 530.

McGlumphy, J. H. 1951. Fruit flavors. *Food Technol.* **5**, 353.

Meigh, D. F. 1952a. Separation of the 3,5-dinitrobenzoates of volatile alcohols by paper chromatography. *Nature* **169**, 706.

Meigh, D. F. 1952b. Separation of the 2,4-dinitrophenylhydrazones of volatile aldehydes and ketones by paper chromatography. *Nature* **170**, 579.

Meigh, D. F. 1956. Volatile compounds produced by apples. I. Aldehydes and ketones. *J. Sci. Food Agr.* **7**, 396.

Northcutt, R. T., Jr., and A. V. Gemmill. 1957. Advanced techniques give year-plus freshness to new banana puree. *Food Eng.* **29** (4), 66.

Nye, W., and H. A. Spoehr. 1943. The isolation of hexenal from leaves. *Arch. Biochem.* **2**, 23.

Postlmayr, H. L., B. S. Luh, and S. J. Leonard. 1956. Characterization of pectin changes in freestone and clingstone peaches during ripening and processing. *Food Technol.* **10**, 618.

Rice, R. G., G. J. Keller, and J. G. Kirchner. 1951. Separation and identification of 2,4-dinitrophenylhydrazones of aldehydes and ketones, and 3,5-dinitrobenzoates of alcohols by filter-paper chromatography. *Anal. Chem.* **23**, 194.

Rothenbach, F., and L. Eberlein. 1905. Über das Vorkommen von Estern in den Fruchten der Bananen. *Deut. Essigind.* **9**, 81.

Serini, G. 1956. Correlation between the content in 2,3-butylene glycol and acetylmethylcarbinol and the degree of ripeness in fruits. II. *Pirus communis, Citrus mobilis, C. sinensis, C. Limonia, Musa sapientum,* and *Prunus persica. Ann. sper. agrar. Rome* **10**, 857.

Spencer, M. S., and W. L. Stanley. 1954. Flavor and odor components in the tomato. *J. Agr. Food Chem.* **2**, 1113.

Stahl, W. H. 1957. Gas chromatography and mass spectrometry. Quartermaster Food and Container Inst., Surveys Progr. Military Subsistence Problems, Ser. I, No. 9, 58.

Steward, F. C. 1955. The biochemical constituents of the banana fruit: A report of a preliminary investigation. Report to the United Fruit Company.

von Loesecke, H. W. 1950. *Bananas.* 2nd ed. Interscience Publishers, Inc., New York.

Webb, A. D., and R. E. Kepner. 1957. Some volatile aroma constituents of *Vitis vinifera* var. Muscat of Alexandria. *Food Research* **22**, 384.

White, J. W., Jr. 1950. Composition of a volatile fraction of apples. *Food Research* **15**, 68.

Winter, M., B. Willhalm, M. Hinder, E. Palluy, and E. Sundt. 1958. Chromatography on columns and paper in the study of the volatile fruit flavor of strawberries. *Perfumery Essent. Oil Record* **49**, 250.

Wiseblatt, L., and F. E. Kohn. 1960. Some volatile aromatic compounds in fresh bread. *Cereal Chem.* **37**, 55.

Wolf, J. 1958. Über die organischen Sauren der Banane. *Z. Lebensm.-Untersuch. u.-Forsch.* **107**, 124.

Woodmansee, C. W., J. H. McClendon, and G. F. Somers. 1959. Chemical changes associated with the ripening of apples and tomatoes. *Food Research* **24**, 503.

at long last...

an **IMITATION RASPBERRY**

with right-off-the-bush flavor!

GIVAUDAN'S NEW IMITATION RASPBERRY FLAVOR is an achievement long desired throughout the flavor-using industries.

Developed with painstaking care through many years of research, it duplicates with all of its fugitive and delicate nuances the rich flavor of the ripe raspberry as it comes fresh from the bush!

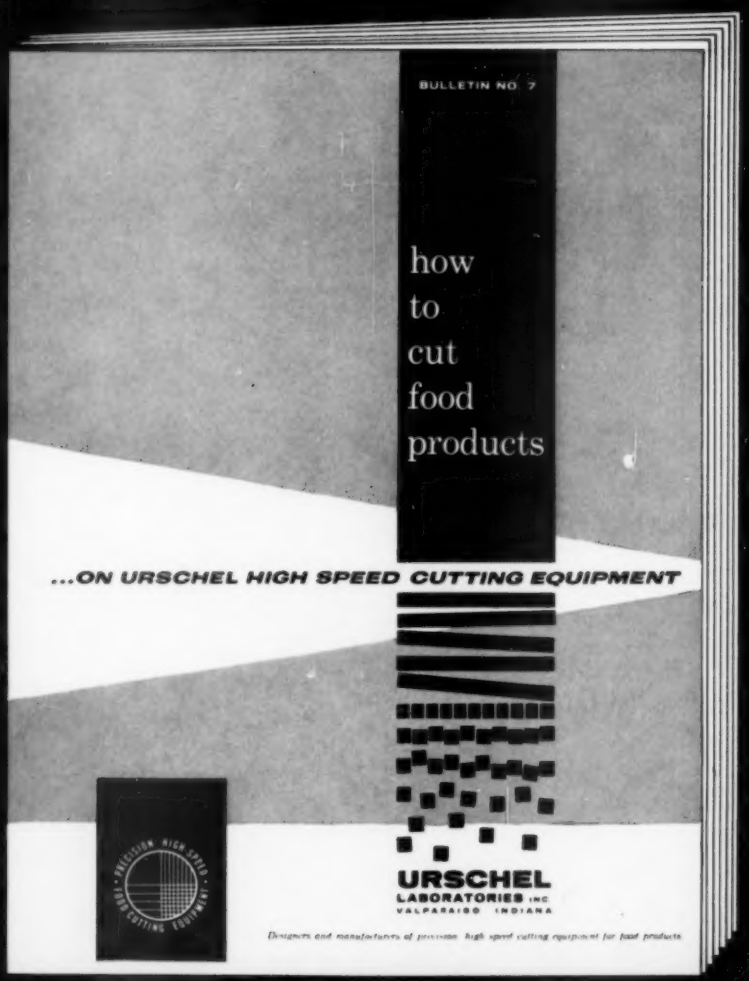
This new Givaudan development provides you with an opportunity to enhance—with true economy—the appeal of your raspberry-flavored products. Its high concentration and proved stability make it ideal for virtually every type of product in which raspberry is a popular flavor. We invite your inquiries.

Givaudan Flavors Inc.

321 West 44th Street, New York 36, N.Y.

Cutting keeps changing ...so does our book*

IT WAS JUST REVISED



Write for this new book today to:

URSCHEL
LABORATORIES INC.
VALPARAISO, INDIANA

Designers and manufacturers of precision, high speed cutting equipment for food products.

Lipid Oxidation in Heat-Sterilized Beef [a]

Marelynn W. Zipser and
Betty M. Watts

Department of Food and Nutrition,
Florida State University, Tallahassee

(Manuscript received June 3, 1961)

SUMMARY

Lipid oxidation decreases as the internal temperature of ground beef round is increased. The production of antioxidant-active substances is responsible for the oxidative stability. The quantity of total lipids or polyunsaturated fatty acids was not markedly changed by extensive heat treatment. Pigment destruction was progressive as heat treatment increased, but in no case was the pigment destroyed completely. Dilute slurries of overcooked beef have a pleasant "meaty" odor and may have some use as cover solutions for cooked meats.

LIPID OXIDATION in uncured meats develops rapidly after heating (Tims and Watts, 1958), and the acceptability of the meat decreases markedly in hours (Chang *et al.*, 1961). Studies of this nature have been carried out on meats cooked to internal temperatures of 70–80°C. However, preliminary observations have indicated that the rate of lipid oxidation was much lower in heat-sterilized beef than in beef heated only to the above temperatures (Florida State Univ., unpublished). Since many canned (heat-sterilized) meat products, without added antioxidants, are on the market, it is of interest to make a systematic investigation of the oxidative reaction in meat heated to progressively higher internal temperatures.

It has been established that rancidity results from the oxidative decomposition of unsaturated fatty acids. The lipid fractions involved primarily are the proteolipids and phospholipids rather than the triglycerides (Younathan and Watts, 1960). Younathan and Watts (1959) recently postulated that the ferric hemichromogen formed in fresh meat under the influence of heat, acts as an active catalyst for fat oxidation.

Several hypotheses were considered as possible explanations for less oxidation in overheated meats. Destruction of heme pigments, resulting in loss of the active catalyst, in the heat-sterilization process might contribute to the slower oxidation in such products. Alternatively, interaction of the reactive lipids with heme pigments or the oxidation of these lipids with subsequent disappearance of the oxidation products, resulting in a loss of oxidizable substrate, might take place. A significant and progressive loss of extractable lipids has been observed in this laboratory in the lateral line tissue of mullet as oxidation proceeds. A third possibility was the production of an antioxidant strong enough to prevent oxidation, in the tissue itself during the heat treatment.

The work reported was designed to investigate the effect of higher heat treatments on lipid oxidation in beef. Pigment destruction, lipid destruction, and antioxidant production were all investigated to some degree to determine the reason for the oxidative stability of extensively heated samples.

METHODS

Preparation of meat. Fresh beef round was used exclusively. Round steak was trimmed of excess fat and ground in Ward's Electric Food Chopper, Model VGS-5169A. Portions of 175 g each were weighed into 307 x 113 C-enameled cans, which were sealed immediately. The cans of meat were heated in an autoclave, which was opened after various periods. The temperature indicated on a thermometer in a control can was recorded as the internal temperature of the samples being removed at that time. The cans were cooled in a running water bath. They were then opened and the contents mixed and placed in bowls, which were covered with aluminum foil and refrigerated (5–7°C).

Tissue lipid oxidation. The 2-thiobarbituric acid test (Tarladgis *et al.*, 1960) was used to measure tissue lipid oxidation during various storage periods. Duplicate determinations were made, and the average was reported as the "TBA number," i.e., mg of malonaldehyde per 1000 g meat.

Concentration of myoglobin. Total pigments were determined by the acetone extraction procedure of Hornsey (1956) as modified by Gantner (1960). Duplicate determinations were made, and the average was reported as g/100 g meat.

Lipid content. The polyunsaturated fatty acid content of beef samples was determined by extracting total lipids (Folch *et al.*, 1957) and assaying for polyunsaturated fatty acids according to the lipoxidase method of MacGee (1959). The concentration of polyunsaturated fatty acids is reported in moles rather than as percent. The percent calculation proposed by MacGee makes assumptions of the mean molecular weight of the fatty acids that would probably not be valid for muscle lipids.

Organoleptic evaluation. The intensity of rancid odor was rated by a panel of trained judges, and the results were evaluated statistically as described by Tarladgis *et al.* (1959). Differences that were significant or highly significant are indicated in the tables. The judges were encouraged to comment on odors other than rancidity that may have been present.

EXPERIMENTAL RESULTS

Lipid oxidation and heme destruction at higher temperature. This experiment was designed to determine the extent of lipid oxidation and the extent of myoglobin destruction in ground beef round samples heated to progressively higher internal temperatures. The temperatures, 80, 95, 99, and 110°, were achieved by putting all samples in the autoclave at the same time, and removing the cans individually after various periods. An "overcooked" sample was secured by leaving meat in the autoclave for 1 hr after the 110°C sample had been removed. The meat was removed from the cans just after cooling, and samples for the TBA test and pigment extraction were taken initially and after 3 and 8 days of refrigerated storage. The data are in Table 1.

[a] A report of work done under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract is being supervised by the Eastern Utilization Research and Development Division of the Agricultural Research Service. Also supported in part by a research grant, RG-6885, from the National Institutes of Health, U. S. Public Health Service.

Table 1. TBA numbers and myoglobin retention of beef round heated to several internal temperatures.

Internal temperature	Days of storage	TBA number	Myoglobin retention [a] %	Sensory score [b]
80°C	0	1.0	100	....
	3	11.	81	2.9
	8	19.	51	2.6(a)
95°C	0	0.9	97	....
	3	7.6	69	....
	8	15.	41	....
99°C	0	0.8	83	....
	3	5.2	70	....
	8	12.	45	....
110°C	0	0.5	76	....
	3	0.7	64	5.8
	8	1.2	61	5.1(b)
110°C + 1 hr at 110°C	0	0.2	34	....
	3	0.2	30	5.3
	8	0.3	32	5.9(c)

[a] Based on the myoglobin value of 0.44 g/100 g meat for 80°C at 0 days storage.

[b] Based on a scale of 1–6 (very strong to no off odor).

b>a (differences highly significant).

c>a, b (differences highly significant).

The TBA numbers become progressively lower with longer cooks throughout all storage periods. Reduction in TBA numbers was greatest between 99 and 110°, indicating that the oxidative reaction is affected drastically in this 11° interval. The threshold for sensory detection of rancidity has been found to be a TBA number of approximately 1. The overcooked sample never reached this level in any storage period, and the 110° sample reached it only after 8 days of storage. This is borne out in the sensory scores shown in Table 1.

The percent of pigment remaining after cooking is based on the value for the 80° sample since it has been observed in this laboratory that little or no pigment destruction takes place when meat is heated to temperatures below 90°. The percent of pigment remaining at 0 days of storage indicates that destruction of myoglobin by heat increases progressively as the internal temperature is increased. Only ⅓ of the pigment remains in the overcooked sample. Loss of pigment is greatest in the additional hour of cooking between the 110° and long-cook samples. Pigment loss during the subsequent 8-day storage is related to lipid oxidation (Watts, 1954). In the 3 samples heated to internal temperatures below 100° the loss range is 38–56%, whereas in the 2 heated to above 100° the loss range is 2–15%. Lipid oxidation is proceeding rapidly in the first 3 samples, and only slightly in the last 2.

The sensory scores previously mentioned indicate that the panel members did not detect rancidity to any degree in the 110° and overcooked samples. They were aware of additional odors, however, which they characterized as "strong but not rancid," "sweet," and "like braised meat."

These results seemed to indicate that pigment destruction might be involved in retardation of the oxidative process. However, products such as pork and veal, which have a pigment concentration not very different from the lowest figures obtained here, are capable of rapid oxidation. For this reason, the other alternatives were explored.

Lipid changes in relation to lipid oxidation. To determine whether lipid destruction had taken place during extensive heating, a sample of ground beef round was "overcooked" and another portion of the sample was heated in a boiling water bath to an internal temperature of 70°C. At 0 days of storage the weight of washed lipid was determined. Raw tissue supplied 51 mg of lipid per g of tissue; 70° sample gave 53 mg; and the overcooked sample gave 52 mg. After 3 days of storage the lipids were again extracted and the molar concentration of polyunsaturated fatty acids (PFA) was determined. The 70° sample contained 7.5×10^{-3} moles of PFA per kg tissue, and the overcooked sample contained 8.3×10^{-3} moles per kg. Apparently there was no measurable destruction of PFA by extensive heat treatment.

Antioxidant production in relation to lipid oxidation. Two different types of experiments were used in determining whether an antioxidant was produced during overcooking. The first involved adding 50% and 10% overcooked ground beef round to raw meat of the same sample (50% and 90%, respectively) and heating to 70°C in a boiling water bath along with a 100% raw meat control. The TBA test was performed on these samples initially and after 3 and 6 days of storage. The results are in Table 2, section A.

The overcooked meat appeared to have an antioxidant effect, especially in 50% concentration. After 6 days of storage, the TBA number was ¼ that of the 0% control, whereas ½ would have been expected because of dilution. The depression at 10% concentration might possibly have been due to dilution.

All 4 samples were presented to the panel of judges after 3 days of storage. The statistical evaluations and sensory scores are shown in Table 2. The judges made no comments. These results are in agreement with the TBA numbers.

As a further test of their antioxidant activity, slurries of overcooked meat were used as covering solutions for slices of roasted eye of round. The meat was roasted to an internal temperature of 165°F in a 325°F oven. The roast was cooled rapidly by wrapping in aluminum foil and immersing in ice water, and then sliced thin with a mechanical slicer. The slices were placed in 307×113 cans, and five different covering solutions were added: water control, 50% slurry, 20% slurry, 2% slurry, and a solution of 1% sodium tripolyphosphate plus 0.22% sodium ascorbate. The cans were stored uncovered at refrigerator temperatures. The TBA test was performed after 4 and 8 days of storage. Both controls and the 50% slurry sample were presented to the panel of judges. The data are in Table 2, section B.

The TBA numbers indicate that the sample covered with a 50% slurry was protected from rancidity over the time studied. The judges did not pick up rancid odors in this sample. They made comments such as "roast meat odor," "stronger meaty odor," and "meaty flavor." In comparison with this sample, the polyphosphate-ascorbate control seemed "washed out" to a few judges—the odor was not rancid but was not as intense as that of the 50% slurry sample. The TBA numbers of the 20%

Table 2. TBA numbers and sensory scores.

Experimental variation	Days of storage	TBA number	Sensory score
A) Ground beef samples cooked with over-cooked beef [a]			
100% control	0	0.2	....
	3	0.3	5.6(a)
	6	0.3	....
50%	0	1.0	....
	3	2.6	5.3(b)
	6	3.8	....
10%	0	2.0	....
	3	8.7	3.3(c)
	6	15.	....
0% control	0	1.9	....
	3	10.	3.0(d)
	6	18.	....
B) Roast beef slices stored in slurries of over-cooked beef [b]			
Water control	4	6.7	2.7(a)
	8	11.	2.8
2% slurry	4	5.0	....
	8	9.7	....
20% slurry	4	3.0	....
	8	5.5	....
50% slurry	4	0.7	5.2(b)
	8	1.0	5.5
1% polyphosphate–0.22% ascorbate control	4	0.0	5.6(c)
	8	0.0	5.3
C) Beef slices stored in various covering solutions [c]			
Water control	4	5.9	2.4(a)
	7	12.	....
20% slurry	4	3.5	4.9(b)
	7	5.4	....
20% slurry with 0.5% polyphosphate	4	0.3	5.7(c)
	7	0.2	....
0.5% polyphosphate control	4	0.3	5.7(d)
	7	0.4	....

[a] a, b>c, d (differences significant).

[b] b, c>a (differences highly significant).

[c] b, c, d>a (differences highly significant).

slurry sample are about ½ those of the water control. This concentration could be said to have a moderate antioxidant effect, and the 2% concentration had a very slight effect.

These 2 experiments demonstrate antioxidant formation in overcooked meat. As a by-product of these experiments, slurries of this meat were found to have a pleasant "meaty" odor. An additional experiment was designed to determine the acceptability of roast beef slices stored in a 20% slurry with added antioxidants, and the effectiveness of such a combination against rancidity. The 20% slurry was chosen because it had a mild "meaty" odor and was about the consistency of a gravy. The TBA test was performed on the samples and appropriate controls after 4 and 7 days of storage. The data are in Table 2, section C.

The TBA numbers are very low for the slurry-antioxidant combination and the polyphosphate control, and the antioxidant capacity of the slurry alone is demonstrated again. All four samples were presented to the judges after 4 days of storage. As shown in Table 2, the polyphosphate and combination samples received identical high average sensory scores. The judges commented that the combination sample was "very fresh" and the polyphosphate control "lacked meaty odor." They were asked to rank the samples according to acceptability. Half of the judges ranked the combination sample as the most acceptable, and the other half selected the polyphosphate control. In all cases the water control was least acceptable, and the 20% slurry next.

DISCUSSION

Uncured canned meats can be stabilized against oxidative rancidity, without the addition of antioxidants, by heat treatment in excess of heat sterilization. This effect is due to the production of antioxidants in the meat itself at high temperatures. No attempt was made to ascertain the nature of the antioxidant or its location within the meat. Perhaps sulfur compounds, resulting from protein breakdown at high temperatures, retard the oxidative process; or the various constituents of the meat may be interacting in some unknown way to produce antioxidants. Triebold (1945) noted that the various formula components of cereal products have a definite effect on the stability of the product. Although the fatty acid composition of the shortening is important, the product stability cannot be predicted from the fat stability. If the antioxidant-active material is located in the soluble fraction of the meat, it should be possible to concentrate and characterize.

For aesthetic and nutritional reasons, commercial use of extensive heat treatment for stabilizing uncured canned meats cannot be encouraged. Thiamine would be almost completely destroyed, and the appearance and odor of the meat would be changed, resulting in a "caramelized" color and strong "canned meat" odor. Actually, some overprocessing occurs in commercial practice, because the National Canners Association does not publish minimum process times for meats, as it does for fruits and vegetables (Frazier, 1958). Good margins of safety are usually allowed. Canned cured meat products have several advantages, undoubtedly accounting for their prevalence on the market. The curing ingredients are known to aid in the destruction of spores of anaerobic bacteria by heat and to inhibit the germination of surviving spores (Frazier, 1958). Less processing time is therefore required, and less thiamine destruction takes place. In addition, rancidity is controlled because of conversion of the heme pigments to the catalytically inactive cured-meat pigment (Younathan and Watts, 1959).

The information provided by these experiments, in addition to giving insight into the oxidative reaction at high temperatures, may have some application. Dilute slurries of overcooked meat provide a pleasant "meaty" odor that enhances the aroma of sliced meat. If the additional needed protection against oxidation of the meat slices can be obtained from antioxidants, either chemical or natural, the use of such slurries as a part of the gravy for prepared dinners might improve the acceptability of such products. It would be of interest to try vegetable extracts, such as those from the skins of onions (Lewis and Watts, 1958), known to have antioxidant capacity, in combination with overprocessed meat.

REFERENCES

Chang, P. Y., M. T. Younathan, and B. M. Watts. 1961. Lipid oxidation in pre-cooked beef preserved by refrigeration, freezing and irradiation. *Food Technol.* **15**, 168.

Florida State University, Department of Food and Nutrition, unpublished results.

Folch, J., M. Lees, and G. Stanley. 1957. A simple method for the isolation and purification of total lipides from animal tissues. *J. Biol. Chem.* **226**, 497.

Frazier, W. C. 1958. "Food Microbiology." McGraw-Hill, New York.

Gantner, G. 1960. Zur bestimmung der farbe van gepokelten fleisch und fleischergeugnissen. *Z. Lebensm. Untersuch. u. Forsch.* **3**, 277.

Hornsey, H. C. 1956. The colour of cooked cured pork. *J. Sci. Food Agr.* **7**, 534.

Lewis, E. J., and B. M. Watts. 1958. Antioxidant and copper binding properties of onions. *Food Research* **23**, 274.

MacGee, J. 1959. Enzymatic determination of polyunsaturated fatty acids. *Anal. Chem.* **31**, 298.

Tarladgis, B. G., M. T. Younathan, and B. M. Watts. 1959. Antioxidants in irradiated cooked pork. *Food Technol.* **13**, 635.

Tarladgis, B. G., B. M. Watts, M. T. Younathan, and L. R. Dugan. 1960. A distillation method for the quantitative determination of malonaldehyde in rancid foods. *J. Am. Oil Chemists' Soc.* **37**, 44.

Tims, M. J., and B. M. Watts. 1958. Protection of cooked meats with phosphates. *Food Technol.* **12**, 240.

Triebold, H. O. 1945. Oxidative deterioration of fats in cereal products. *J. Am. Oil Chemists' Soc.* **22**, 334.

Watts, B. M. 1954. Oxidative rancidity and discoloration in meat. In "Advances in Food Research" **5**, 1.

Younathan, M. T., and B. M. Watts. 1959. Relationship of meat pigments to lipid oxidation. *Food Research* **24**, 728.

Younathan, M. T., and B. M. Watts. 1960. Oxidation of tissue lipids in cooked pork. *Food Research* **25**, 538.

A Method of Analysis of Nonvolatile Encapsulated Substances

Robert T. Maleeny

Fritzsche Bros., Inc., 76 Ninth Avenue, New York 11, New York

(Manuscript received March 13, 1961)

SUMMARY

A procedure is presented for determining nonvolatile substances encapsulated by spray drying or some other similar technique. The method, a liquid-liquid extraction adaptable for the analysis of both solvent and water-soluble extracts, has been used to determine the concentration of oleoresins of capsicums, black pepper, paprika, turmeric and coffee encapsulated in gum acacia.

ALTHOUGH most substances encapsulated by spray drying or some other technique are volatile, the entrapped phase is sometimes wholly or partially nonvolatile. The concentration of this fraction can be calculated by the manufacturer and the volatile content determined analytically, but quick and easy analysis of materials for concentration of the nonvolatile portion is important to quality control, research and theoretical interest. The method presented here for determination of this portion meets the requirements of speed and ease of operation, and yields reasonable accuracy with the equipment found in the average small laboratory.

The method entails organic-solvent extraction of the nonvolatile material from a water solution. The nonvolatile entrapped phase is separated from the encapsulating agent and the amount extracted by the organic solvent can be determined by weighing the evaporation residue. Conversely, if it is assumed that only the encapsulating agent is water-soluble, the concentration of this component in the sample can be ascertained by evaporation of the water phase of the extraction.

PROCEDURE

Accurately weigh, to the nearest milligram, a sample of about 1.000 g, and transfer it to a Waring blender (Scientific Glass Company, Cat. 59, No. S-6729 Model EP-1). Add 60 ml of reagent ethyl ether (Fisher Scientific Company, Cat. 123, No. E-138) and 20 ml of distilled water. Mix at maximum speed for at least 30 sec to ensure complete solution and dispersion. Connecting the mixer to a rheostat so the rate of mixing can be increased slowly prevents splattering the container walls with undissolved particles. Then add 20 ml of 95% ethyl alcohol and mix again at high speed for at least 30 sec. Quantitatively wash the mixture with water into a 250-ml separatory funnel (Fisher Scientific Company, Cat. 61, No. 10-437-15). Allow it to stand until the layers separate. Draw off the bottom water layer into another 250-ml separatory funnel. To this fraction add a mixture of 35 ml ether and 15 ml ethyl alcohol. Shake well, and let the phases separate. Drain the bottom water layer into a weighed 250-ml boiling flask (E. H. Sargeant & Company, Cat. 100, No. S-33830) if the quantity of water-soluble components is to be determined; otherwise, discard it. Combine the ether extracts and wash with two 25-ml portions of water to ensure complete removal of the water-soluble components. Add these washes to the water in the boiling flask if the water-soluble fraction is being determined. Transfer the combined ether extract to another weighed 250-ml boiling flask, and remove all but 50–75 ml of the solvents from the solutions in the flask by distillation. Then dry the flasks for 16 hr in an oven at 105°C. Report results as percent nonvolatile ether extract or percent ether extract.

CALCULATIONS

A) $$\% \text{ nonvolatile ether extract} = \frac{R_e}{S} \times 100$$

in which S = weight of sample
R_e = weight of ether-soluble residue

B) $$\% \text{ ether extract} = 100 + W - \left[\frac{R_w}{S} \times 100 \right]$$

in which S = weight of sample
R_w = weight of water-soluble residue
W = water content of sample

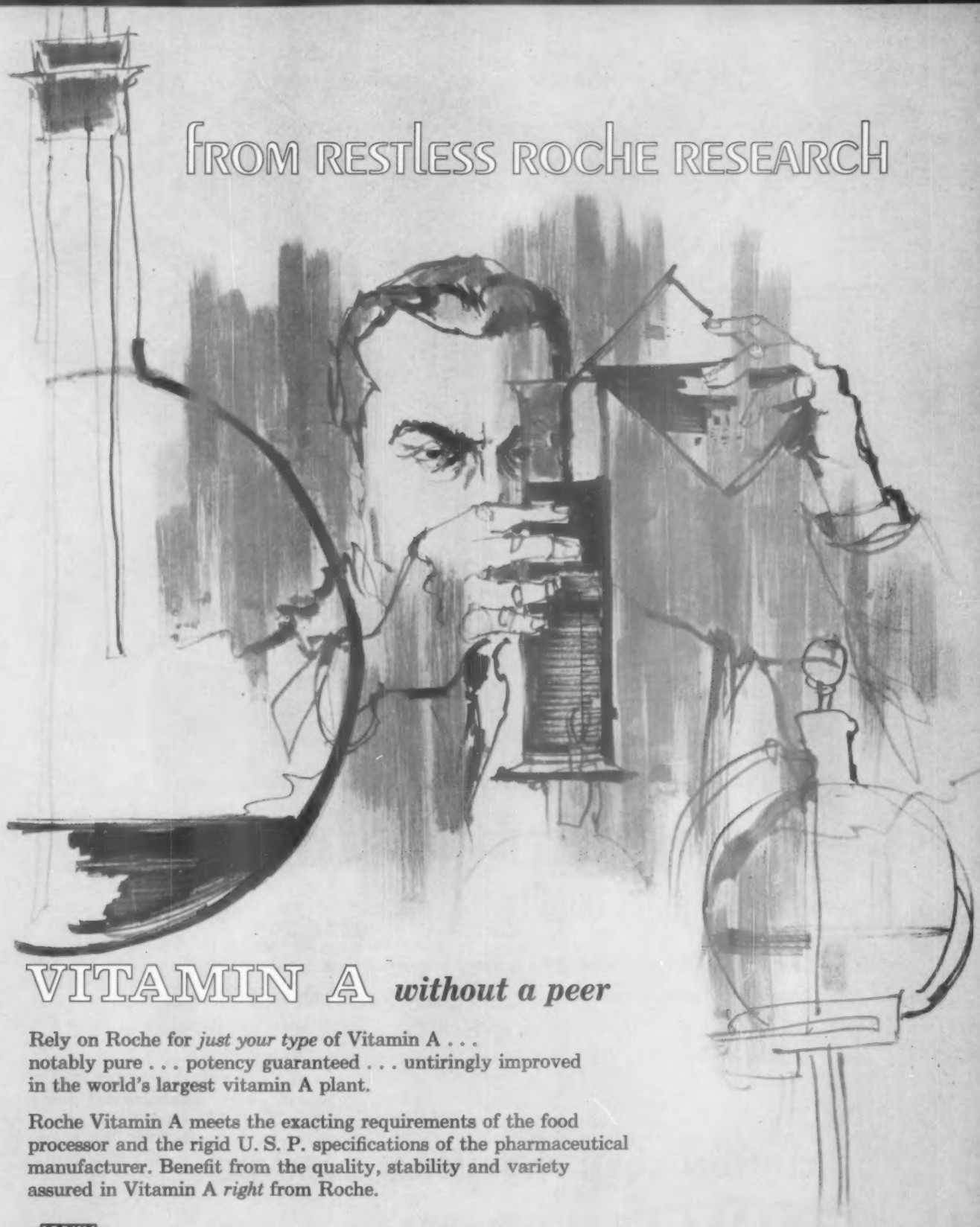
DISCUSSION

Since the coating of an effectively encapsulated nonvolatile substance is impermeable, preventing extraction of the internal phase by organic solvents, the protective colloidal film must be dissolved before the dispersed phase is exposed to extraction. Also necessary, is violent agitation with a high degree of shear, since simple mixing of the solution of the encapsulated material with solvent is not adequate for effective extraction. Apparently, the dispersed phase of the dispersion created when a spray-dried oil is dissolved in water is surrounded by a submicroscopic film (Becher, 1957) that prevents extraction of the dispersed phase by the solvent and must be ruptured mechanically and chemically before contact between the oil and solvent and subsequent solution is effective. A Waring blender is satisfactory both for effecting solution and for rupturing the interfacial film mechanically. To insure that exposure of the dispersed phase is complete, it is advisable to precipitate the colloidal film by adding an alcohol (Mantell, 1954). Since the reaction is apparently dependent on the concentration of the hydroxyl group, any convenient alcohol can be used, though ethyl alcohol has been found best suited for the purpose since the resulting precipitate is more easily handled than those with other alcohols. If substitution is made, it should be on a hydroxyl replacement basis so that the alcohol added is enough to disperse the gum momentarily but not enough to cause permanent coagulation.

Once the interfacial film has been broken, extraction can be conducted in a routine manner, following the relationship (Glasstone, 1946):

$$R_n = R\left[\frac{KW}{KW + E}\right]^n$$

FROM RESTLESS ROCHE RESEARCH



VITAMIN A *without a peer*

Rely on Roche for *just your type* of Vitamin A . . .
notably pure . . . potency guaranteed . . . untiringly improved
in the world's largest vitamin A plant.

Roche Vitamin A meets the exacting requirements of the food processor and the rigid U. S. P. specifications of the pharmaceutical manufacturer. Benefit from the quality, stability and variety assured in Vitamin A *right* from Roche.

ROCHE

Fine Chemicals Division • **HOFFMANN-LA ROCHE INC** • Nutley 10, New Jersey
In Canada: Hoffmann-La Roche Limited, St. Laurent, Montreal 9, P.Q.

ROCHE®

When you use our products in your products, quality joins quality

The fine foods you process gain a new measure of sales appeal and consumer satisfaction when you use CLINTON products from corn. Over 50 years of corn processing experience assures the quality of CLINTON CORN SYRUP, CORN STARCH, REFINED CORN OIL, LACTIC ACID and CLINTOSE BRAND DEXTROSE.

Watch Clinton for new product developments

CLINTON CORN PROCESSING COMPANY

CLINTON

CLINTON, IOWA

448B

Table 1.—Summary of analyses of various encapsulated substances.

Sample	Encapsulated material	No. of samples	% solvent extract			No. of samples	% water extract		
			Analyzed	Theoretical	Recovered		Analyzed	Theoretical	Recovered
1	Oleoresin capsicum, Mombassa	3	20.9	21.1	99.1	3	74.7	72.6	102.9
2	Oleoresin capsicum, African	2	20.6	21.1	97.6	2	72.8	72.6	100.3
3	Oleoresin capsicum, high pungency	6	21.1	21.3	99.1	6	73.1	73.2	99.9
4	Oleoresin paprika, 100,000 C.U.	3	49.9	49.4	101.3	3	45.1	44.5	101.3
5	Oleoresin paprika, 40,000 C.U.	3	17.2	17.5	98.3	3	70.4	71.1	99.0
6	Oleoresin black pepper	3	15.0	15.4	97.4	3	74.6	72.3	103.2
7	Oleoresin turmeric	....	....	....	....	3	85.8	86.2	99.5
8	Vegetable oil compound	2	38.3	39.1	98.1	2	56.5	55.8	101.3
9	Oleoresin red pepper, American Lot 1	4	21.2	21.5	98.6	....	....	....	....
10	Oleoresin red pepper, American Lot 2	5	22.3	21.5	103.7	....	....	....	....
11	Oleoresin red pepper, American Lot 3	4	21.2	21.5	98.6	....	....	....	....
12	Oleoresin coffee	2	23.1	22.6	102.2	....	....	....	....

in which

R_n = the amount of solute remaining in the extracted phase after n extractions

R = weight of solute

W = ml of extracted phase

E = ml of extracting solvent

K = distribution coefficient

$$K = \frac{C \text{ water}}{C \text{ solvent}}$$

in which

C water = equilibrium concentration of solute in water phase

C solvent = equilibrium concentration of solute in solvent phase

Since most dispersions encountered contain not one but several solutes of varying concentrations, it is usually not possible to determine an accurate value for the distribution coefficient. However, since most organic materials are relatively insoluble in water but freely soluble in ether, an empirical value of 0.02 can be assigned to the distribution coefficient. Assuming this figure to be functional for most cases, two washes with solvent can be seen to be more than adequate, the theoretical error being less than 0.20%. Likewise, for water extraction of the ether phase, the same value of 0.02 can be assigned to K since most encapsulating agents are insoluble in ether but relatively soluble in water. The error here can also be assumed to be negligible.

Since the encapsulated or ether-soluble extract is the object of prime importance, it is usually not necessary to retain and analyze the water extract. However, some substances, such as oleoresin turmeric, may contain ingredients, such as propylene glycol, that are not truly nonvolatile. Therefore, the answers obtained by drying the ether extract at 105°C, will be low. If, however, the water extract is evaporated to dryness, the percent residue can be used to calculate the percent ether-soluble. If this technique is used, a correction must be made for the water content of the sample (Guenther, 1948).

From tests so far, it appears that for the solvent extract, the precision of a single measurement is 0.30% and the average deviation of the mean 0.15%. For the water extract, the precision of a single measurement is 2.10% and the average deviation of the mean 1.05% (Kolthoff and Sandell, 1952). Thus, it can be seen that, whenever possible, it is preferable to determine the solvent extract directly. In any event, the accuracy of determination of either phase will be adequate for the usual encapsulated substance.

Analyses have been conducted on such encapsulated substances as oleoresins of capsicums, turmeric, black pepper and coffee. Only turmeric and black pepper proved troublesome, since they contain volatile components that are driven off in the drying step. The concentration of these materials can be determined indirectly, however, by analysis of the sample for water-soluble components. The results of typical analyses are shown in Tables 1 and 2.

Table 2. Total analysis of some encapsulated substances.

Sample	Encapsulated material	Water extract	Solvent extract	Water	Total
1	Oleoresin capsicum, Mombassa	74.7	20.9	4.5	100.1
2	Oleoresin capsicum, African	72.8	20.6	4.8	98.2
3	Oleoresin capsicum, high pungency	73.1	21.1	5.5	99.7
4	Oleoresin paprika, 100,000 C.U.	45.1	49.9	4.4	99.4
5	Vegetable oil compound	56.5	38.3	7.4	102.2

REFERENCES

Becher, Paul. 1957. "Emulsions: Theory and Practice." 95. Reinhold Publishing Corp., New York.

Glasstone, Samuel. 1946. "Textbook of Physical Chemistry," 2nd ed. 742. Van Nostrand, New York.

Guenther, Ernest. 1948. "The Essential Oils," Vol. I. 323. Van Nostrand, New York.

Kolthoff, I. M., and E. B. Sandell. 1952. "Textbook of Quantitative Inorganic Analysis," 3rd ed. 271. Macmillan, New York.

Mantell, C. L. 1954. Natural plant hydrocolloids. 24. "Advances in Chem. Ser." No. 11, American Chemical Society, Washington, D. C.

Effect of Processing on Distribution and In Vitro Availability of Niacin of Corn (Zea mays) [a, b]

[1] (Manuscript received October 8, 1960)

Ricardo Bressani, Roberto Gomez-Brenes, and Nevin S. Scrimshaw

Institute of Nutrition of Central America and Panama (INCAP), Guatemala, C. A.

SUMMARY

Niacin distribution was studied in one "starchy" and one "flint" sample of yellow corn. On the basis of 10% moisture, the seed coat averaged 3.2 mg, and the endosperm and the germ 2.0 mg per 100 g each. The endosperm contributed 80% of the total niacin, whereas the germ and the seed coat respectively supplied 11 and 9%. Of the niacin in the endosperm, germ, and seed coat, respectively 55, 73, and 42% were extractable with water at room temperature. During the lime cooking, the endosperm lost an average of 19% of its niacin, and the germ, 56%. The cooking liquor contained 0.43 mg per 100 g of niacin, equivalent to a total loss of around 22%. Of the niacin in raw corn, nixtamal (masa), and tortillas, respectively about 68, 76, and 73% were extractable with water at room temperature. Hydrolysis with pepsin yielded about 69% of the niacin of all samples. After trypsin hydrolysis, and final digestion with pancreatin, values of 78 and 100% of the niacin, respectively, were found compared with sulfuric acid hydrolysis of the same material. Differences in amino acid balance rather than in "bound" niacin thus appear responsible for the differences between raw and processed corn in biological activity and pellagragenic action.

ALTHOUGH PEOPLE who eat large amounts of corn *(Zea mays)* traditionally have an increased susceptibility to pellagra (Anon. 1954), this disease is not common in the rural populations of Latin American countries despite large consumption of this cereal (Bressani *et al.*, 1958). The relationship between corn diets and pellagra, as it formerly occurred in the United States or is found today in countries like Egypt, Yugoslavia, and Basutoland, is still not fully understood.

The alkaline treatment of corn has been reported to destroy its pellagragenic factor (Borrow *et al.*, 1948; Woolley, 1946). Subsequent evidence suggests (Elvehjem and Krehl, 1955; Koeppe and Henderson, 1955; Krehl *et al.*, 1944, 1945a, b, 1946a, b) that pellagra is due to an imbalance of the essential amino acids, increasing the niacin requirement of the animal. Lime treatment of the corn, as practiced in Mexico and Central America (Cravioto *et al.*, 1952), appears to correct this amino acid imbalance partly; at least, rats and other experimental animals grow better and are less subject to pellagra when fed lime-treated rather than raw corn (Cravioto *et al.*, 1952; Fiorentini *et al.*, 1956; Laguna and Carpenter, 1951; Massieu *et al.*, 1956; Squibb *et al.*, 1959).

Bressani and Scrimshaw (1958) demonstrated that lime treatment of corn significantly lowers the solubility of zein, so that, at least in the rat, digestive enzymes make it easier for the blood to absorb amino acids than when untreated corn is fed. No significant differences are found in the amino acid composition of raw and lime-treated corn after acid hydrolysis (Bressani and Scrimshaw, 1958).

Kodicek (1960) and Kodicek *et al.* (1956) found, from both swine growth studies and paper chromatography, that part of the niacin in corn occurs in a "bound" form. They conclude that the pellagragenic action of corn is due to the fact that this "bound" niacin is unavailable to the animal organism. More recently, Pearson *et al.* (1957) showed that simple boiling of corn has the same effect as lime treatment on "bound" niacin or amino acid availability.

The present study represents a further effort to determine the effect of processing on the distribution and availability of niacin in corn.

MATERIALS AND METHODS

One sample each of a yellow, starchy type of "highland corn" and a "lowland corn" with a yellow, flint-type kernel was subjected to the following treatments: 1) *cooking in lime water* by procedures described previously (Bressani and Scrimshaw, 1958; Bressani *et al.* 1958), 2) *germination* for four days at room temperature after sterilizing the raw kernels 2 min with 0.2% $HgCl_2$ solution and washing three times with distilled water, 3) *pressure cooking* of a mixture of 100 g of corn and 80 ml of water for 30 min at 15 lb pressure and 121.5°C, 4) *toasting* 20 min on an electric hot-plate, 5) *steaming* raw corn 10 min in an autoclave with no water added at 15 lb pressure and 121°C. Part of the material resulting from each of these treatments was dried and ground to pass 40 mesh.

The remaining kernels, in lots of 100, were manually separated into seed coat, endosperm, and germ fractions. If not already cooked, softening 30 min in water at room temperature facilitated separation. This dissected material was air-dried to constant weight, pooled, ground to 40 mesh, and stored at 4°C.

The niacin content of the raw corn, anatomical fractions and products of the different treatments, was estimated microbiologically in duplicate samples after hydrolysis for 30 min with 1*N* sulfuric acid in the autoclave at 15 lb pressure. The pH of the hydrolysate was adjusted to 6.8, and 5 aliquots of different volume were distributed in tubes replicating each aliquot three times. Inoculation was carried out with *Lactobacillus arabinosus 17-5*, using Difco media (Difco Laboratories, Detroit, Michigan).

[a] This work was assisted by a grant-in-aid from the Williams Waterman Fund of the Research Corporation.

[b] Part of a thesis submitted by Roberto Gómez-Brenes in partial fulfillment of the requirements for obtaining a degree from the Chemistry and Pharmacy Department of the University of Nicaragua. INCAP Publication I-165.

Table 1. Distribution of niacin in whole corn, and anatomical fractions of the grain before and after cooking (values adjusted to 10% moisture).

Sample	Before lime cooking		After lime cooking		Losses	
	Weight (% of whole grain)	Niacin (mg/100 g)	Niacin (% of total in grain)	Niacin (mg/100 g)	Niacin (% of total in grain)	Niacin loss in fraction	Niacin loss or gain as % in whole grain
Highland corn							
Whole grain	100.0	2.21	100.0	1.66	100.0	24.9	−26.2
Endosperm	84.0	1.99	79.5	1.72	70.2	13.6	−11.7
Germ	11.0	2.01	10.5	0.84	4.5	58.2	− 6.4
Seed coat	5.0	4.22	10.0	.....	.....	100.0	.....
Cooking water	.....	.....	.....	0.52	25.3	.....	+10.0
Lowland corn							
Whole grain	100.0	2.14	100.0	1.63	100.0	23.8	−25.6
Endosperm	82.0	1.93	81.2	1.47	66.5	23.8	−19.5
Germ	11.0	1.92	10.8	1.07	6.4	44.3	− 4.9
Seed coat	7.0	2.21	7.9	.....	.....	100.0	.....
Cooking water	.....	.....	.....	0.49	27.1	.....	+10.8

The water-soluble niacin was estimated in water extracts of two or three 1-g samples. These extracts were prepared by continuous shaking for 30 min with 100 ml of distilled water at room temperature; the hydrolysis was omitted for the aqueous extract samples. The *in vitro* niacin hydrolysis studies were carried out with 5-g samples, using enzymatic digestion with pepsin, trypsin, and pancreatin for 24 or 72 hours, as previously described (Bressani and Scrimshaw, 1958).

RESULTS

Table 1 shows the niacin distribution within the kernel of each of the two corn samples, before and after lime treatment. The seed coat of the grains contained more niacin than did the endosperm or the germ. Because the endosperm is large it contained about 80% of the total niacin, whereas the germ contributed only 11%. Although the seed coat contained proportionately more niacin than the other two anatomical fractions, it represented only about 6% of its weight, and therefore contributed only about 9% of the total niacin content for the corn grain.

Table 1 also shows the effect of lime cooking on the niacin distribution in the component parts of the corn kernel. The endosperm of the highland corn lost 13.6% of its niacin, and the lowland corn sample lost 23.8%. These same samples showed a niacin decrease in the germ of 58.2% in the former and 44.3% in the latter. The cooking water of the highland corn had 25.3% of the original total niacin, the lowland sample, 27.1%. The amount of niacin in the cooking water resulted from individual niacin losses of: in highland corn, 11.7% from the endosperm, 6.4% from the germ, and 10.0% from the seed coat removed by the cooking liquor; and in lowland corn, 19.5% from the endosperm, 4.9% from the germ, and 10.8% from the seed coat.

Table 2. Distribution and water-extractable niacin in fractions and products obtained from corn (values adjusted to 10% moisture).

	Niacin concentration (mg/100 g)	Niacin in water extract (mg/100 g)	Niacin in residue (mg/100 g)	% niacin extracted in water
Highland corn				
Raw	2.23	1.54	0.70	68.7
Endosperm	1.99	1.04	0.98	51.5
Germ	2.01	1.60	0.60	72.8
Seed coat	4.22	1.66	2.61	38.8
Nixtamal	1.59	1.22	0.35	77.8
Tortilla	1.72	1.22	0.34	73.5
Cooking water	.....	0.37	.....	17.7
Lowland corn				
Raw	2.15	1.42	0.68	67.7
Endosperm	1.93	1.09	0.81	57.4
Germ	1.92	1.46	0.51	74.1
Seed coat	2.21	1.08	1.36	44.3
Nixtamal	1.62	1.18	0.41	74.3
Tortilla	1.64	1.16	0.43	73.0
Cooking water	.....	0.35	.....	16.9

Table 2 shows the quantity of niacin extracted with water from the corn samples. Results were similar with the two whole corns and their respective fractions. About 55% of the niacin from the endosperm and 73% from the germ were extractable with water at room temperature. An average of only 42% of the niacin content of the seed coat and 68% of the total niacin from the two whole ground grains was extracted. Water-extractable niacin averaged 68% from raw corn, and respectively 76 and 73% from nixtamal (masa) and tortilla.

The water-extractable niacin from the other corn preparations is shown in Table 3. In this experiment an average of 71% of the niacin was extracted from raw corn, 66% from toasted grain, 68% from the steamed corn, and 63% from boiled corn. Thus, none of the treatments applied to the raw corn had any significant effect on the proportion of water-extractable niacin.

Table 3. Water-extractable niacin from raw and processed corn (averages of four duplicate samples, values adjusted to 10% moisture).

Niacin	Corn preparation			
	Raw	Roasted	Steamed	Boiled
Highland corn				
Total (mg/100 g)	2.05	2.14	2.06	2.09
Water extract (mg/100 g)	1.50	1.42	1.41	1.32
Residue (mg/100 g)	0.55	0.72	0.65	0.77
Percent niacin in water-extract	73.2	66.4	68.4	63.2
Lowland corn				
Total (mg/100 g)	2.11	2.05	1.93	2.09
Water extract (mg/100 ml)	1.46	1.36	1.31	1.31
Residue (mg/100 g)	0.65	0.69	0.62	0.78
Percent niacin in water extract	69.2	66.4	68.0	62.7

The enzymatic release *in vitro* of niacin from corn and corn preparations, using 72-hour enzymatic hydrolysis, is shown in Table 4 for the lowland corn, and in Fig. 1 for the highland corn. Fig. 2 shows 24-hour hydrolysis results for the highland corn and its tortilla.

Pepsin hydrolysis yielded better than 69% of the original niacin, as shown in Table 4 and Fig. 1. This amount was probably not due to the action of the enzyme, however, since similar amounts of niacin were extractable with water. Enzymatic hydrolysis with trypsin, following the pepsin digestion, increased niacin availability to about 78% of the original value, whereas final digestion with pancreatin raised the amount of niacin to values approaching 100% of the niacin present in corn as determined by 1*N* sulfuric acid hydrolysis.

In all cases, lime-treated corn, raw corn, and the other corn preparations yielded niacin by enzymatic hydrolysis at the same rate. In the experiment shown in Fig. 2, the enzymatic hydrolysis lasted 24 hr. Tortillas had a lower initial niacin content but released more niacin than raw corn on a percent basis. Amounts of niacin expressed on an absolute basis were essentially the same for raw corn and tortillas after pancreatin

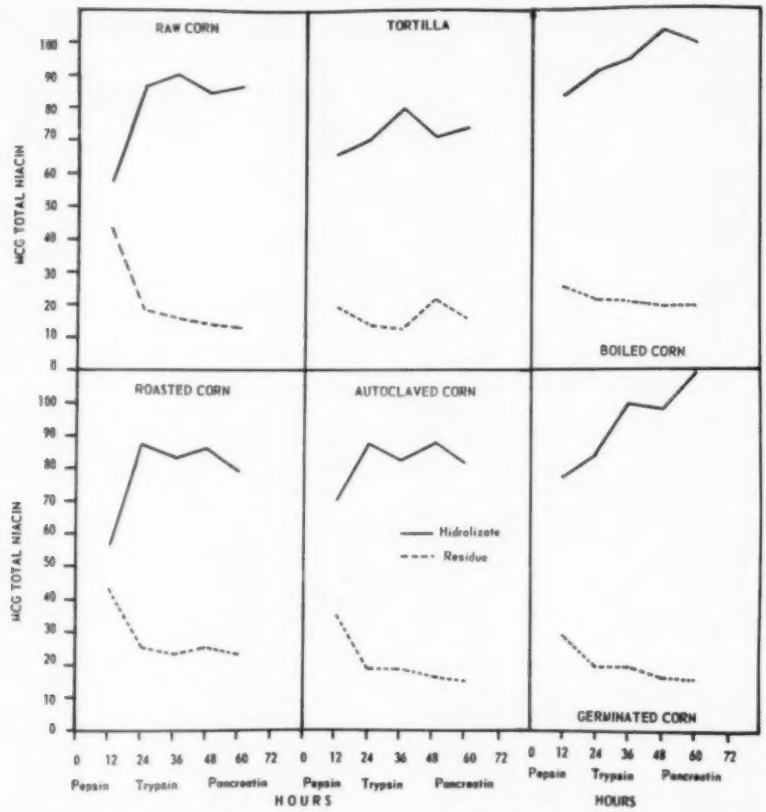


Fig. 1. Release of niacin from a 5-g sample of corn and various corn preparations by enzymatic hydrolysis (72-hour trial).

digestion. Residue analysis showed only small amounts of niacin, and the recoveries using the niacin values of the hydrolysate and the residue approximated 100%.

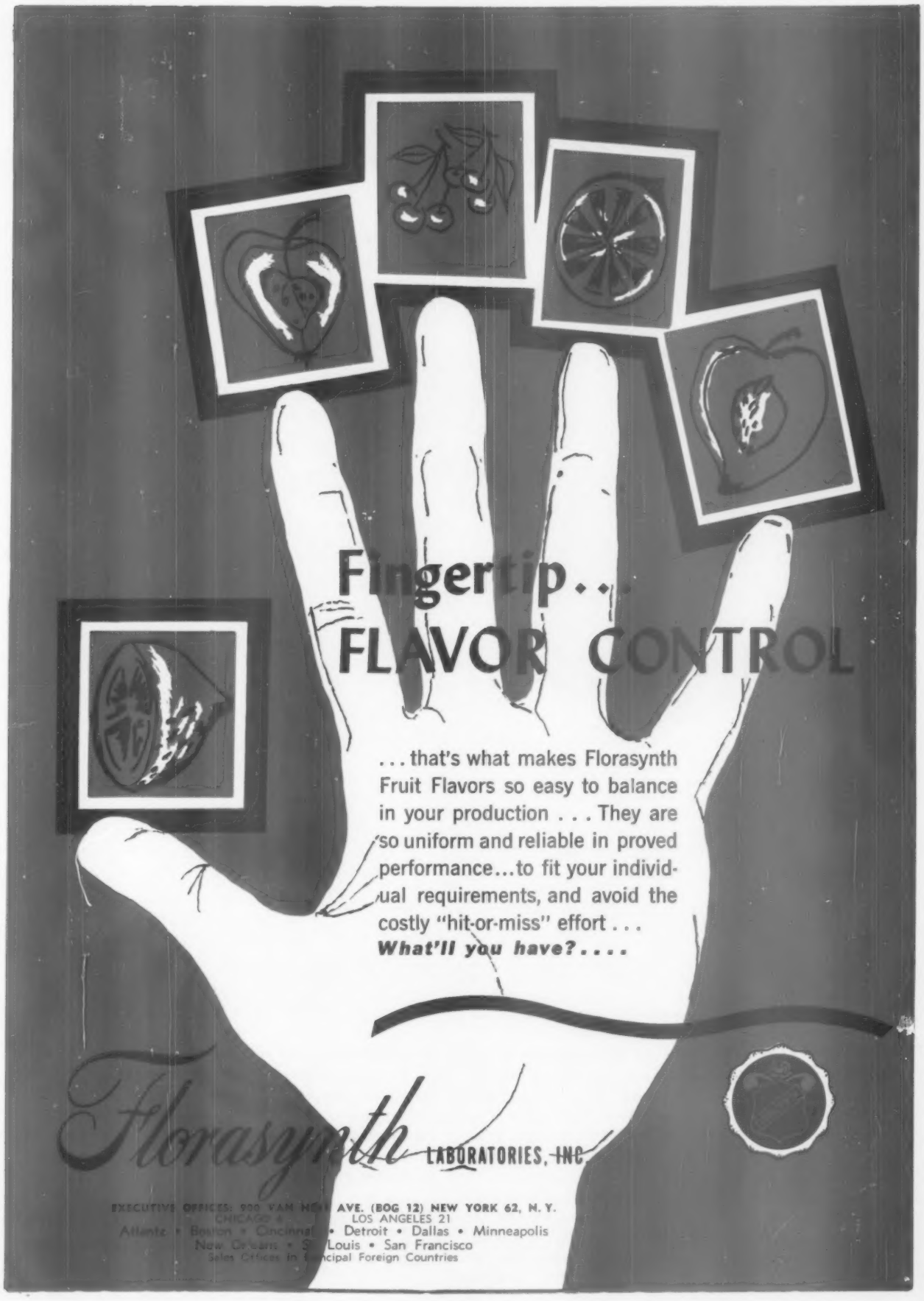
DISCUSSION

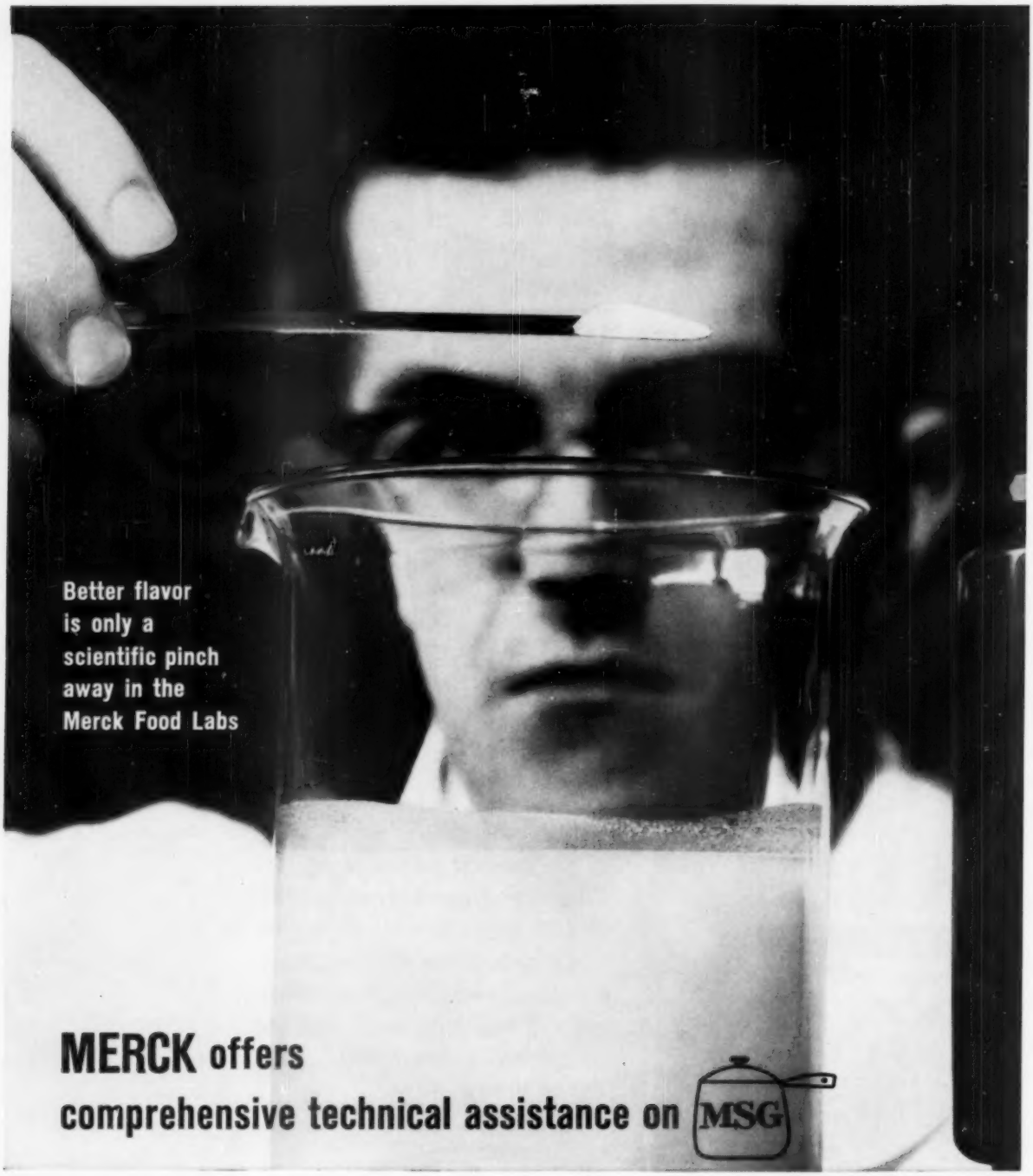
The niacin concentrations were similar in the germ and endosperm of the grain, and much higher in the seed coat. Nevertheless, the endosperm contributes the most niacin to the whole grain because it is the largest part of the kernel. This fact is important because, during tortilla preparation in Central America, the seed coat is discarded and its niacin lost (Bressani and Scrimshaw, 1958; Bressani *et al.*, 1958), whereas elsewhere in Latin America, the germ may also be removed (Jaffe *et al.*, 1950) in preparing corn for human consumption.

Part of the niacin in each of the three fractions of the uncooked but ground corn kernel is not extractable with water under the conditions used. The results show that on the basis of 10% moisture, only about 42% of the niacin in the seed coat and 54% of that in the endosperm is soluble in water, whereas the quantity extractable from the germ in this manner is approximately 73%. Sweeney (1951) and Sweeney and Parrish (1954) reported that most of the niacin in the seed coat of the corn grain is in the "bound" form, and that its full activity could be obtained by treating the sulfuric acid hydrolysate with sodium hydroxide at pH 12. The seed coat is of further interest since Borrow *et al.* (1948) suggested that a pellagragenic factor is present for the rat.

Table 4. In vitro release of niacin by four hydrolytic agents from the lowland corn preparations (averages of duplicate samples: values adjusted to 10% moisture).

	1*N* H_2SO_4 (reference)		Pepsin (12 hr)				Trypsin (36 hr)				Pancreatin (72 hr)			
	Hydrolysate	Residue	Hydrolysate		Residue		Hydrolysate		Residue		Hydrolysate		Residue	
Sample	μg/100 g	μg/100 g	μg/100 g	% ref.	μg/100 g	% rec.	μg/100 g	% ref.	μg/100 g	% rec.	μg/100 g	% ref.	μg/100 g	% rec.
Raw corn	103.5	0	62.0	69.5	24.0	93.2	79.0	76.4	19.5	95.2	85.3	82.4	17.5	99.3
Lime-treated corn	85.5	0	56.0	65.5	28.0	98.3	68.5	80.2	27.5	112.2	74.0	86.5	24.0	114.5
Roasted corn	105.5	0	73.0	69.2	28.5	96.2	85.0	80.5	27.0	106.0	95.0	90.0	24.0	112.7
Steamed corn	99.5	0	71.0	71.5	20.5	92.0	82.0	82.5	15.0	97.5	103.0	103.5	10.0	113.5


Fingertip...
FLAVOR CONTROL
...that's what makes Florasynth Fruit Flavors so easy to balance in your production . . . They are so uniform and reliable in proved performance...to fit your individual requirements, and avoid the costly "hit-or-miss" effort . . .
What'll you have?....
Florasynth LABORATORIES, INC
EXECUTIVE OFFICES: 630 VAN NOR AVE. (BOG 12) NEW YORK 62, N. Y.
CHICAGO 6 LOS ANGELES 21
Atlanta • Boston • Cincinnati • Detroit • Dallas • Minneapolis
New Orleans • St. Louis • San Francisco
Sales Offices in Principal Foreign Countries



MERCK offers comprehensive technical assistance on MSG

It doesn't always take a major change in formulation to effect an improvement in a food product's flavor. Sometimes it can be done with the equivalent of a pinch of MSG . . . or a slight modification in formula to get the most out of the MSG that is already in the product. It's all a matter of experience with MSG and a desire to work hard for the right answer.

You'll find specialists in the Merck Food Laboratories strong on both counts. This creative group offers a broad range of technical services relating to the use of MSG, from evaluating your new product formulations to improving flavor of your existing products.

Just as a reminder, Merck is in a better position than ever before to satisfy your appetite for MSG. A $2 million plant expansion has increased production capacity for Merck MSG by 100%. For details on delivery of MSG or technical assistance on its use, simply call your Merck representative.

452B

MERCK CHEMICAL DIVISION
MERCK & CO., INC. • RAHWAY, NEW JERSEY

Bressani *et al.* (1958) and Bressani and Scrimshaw (1958) showed that, during tortilla preparation in Central America, about 17% of the niacin is lost in the cooking water when the raw corn is cooked and soaked in lime water before grinding. The largest part of this loss comes from the physical loss of the seed coat. The seed coat contributes about 9% of the niacin of the whole grain, or about 0.19 mg per 100 g, compared with a total loss of niacin of about 0.43 mg per 100 g. Since the water extractability of the niacin is not significantly greater in nixtamal (masa) and tortillas than in raw corn, the more favorable effects on growth attributed to lime-treated corn are apparently not due to a change in niacin solubility.

Furthermore, the processing treatments given the other corn preparations did not hydrolyze the niacin, since the quantity of the vitamin extractable with water from these materials was also comparable to that obtained from raw corn. The quantity of niacin extracted from these preparations was about two-thirds of the vitamin present in the grain, leaving one-third of the total niacin in the residue, a figure only slightly lower than the corresponding values for the nixtamal (masa) and the tortilla. Nearly 20% more water-extractable niacin was found in this study than reported by Pearson *et al.* (1957), probably because of minor differences in cooking procedure.

The *in vitro* enzymatic studies, carried out for both 60 and 72 hours, indicate that niacin is available *more rapidly* from tortillas and roasted, germinated, steamed, or autoclaved corn than from raw corn. Similar *total quantities* of niacin were available from the treated and raw corn samples. The amount of niacin found after the pepsin hydrolysis appears to represent no more than the amount of free niacin in the grain. The addition of the other proteolytic enzymes liberated the niacin, which was not extractable with water. More than 80% of the niacin in corn was obtained after 24 hours of enzymatic hydrolysis in all cases studied, which indicates that the vitamin in corn can be freed almost totally by prolonged proteolytic action.

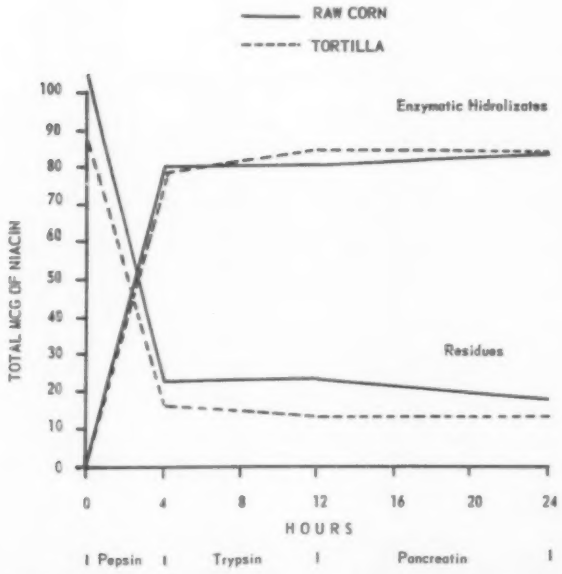


Fig. 2. Release of niacin from a 5-g sample of corn and tortilla by enzymatic hydrolysis (24-hour trial).

Since the digestive process does not last 72 hours, shorter periods of enzymatic hydrolysis were studied, using three proteolytic enzymes on both corn and tortilla. At the end of 4 hr of hydrolysis, similar absolute quantities of niacin were obtained from corn and tortillas. As in the previous cases, the trypsin and pancreatin hydrolysis increased the quantity of niacin in the hydrolysate through their action on the residual niacin of corn and tortilla.

The data thus indicate that, under the conditions employed, niacin is as available in raw corn as in lime-treated corn. As suggested previously (Bressani and Scrimshaw, 1958; Cravioto *et al.*, 1952), other factors, such as a more favorable balance of available amino acids, must be responsible for the better growth observed in experimental animals fed lime-treated corn than in those fed raw corn.

Kodicek (1960), Carpenter *et al.* (1960), and Chaudhuri and Kodicek (1960) reported that the "bound" niacin in corn and other cereal grains can be released only by an alkaline, and not by enzymatic, digestion, either *in vitro* or *in vivo* in rats and pigs. Instead of using corn as the sole source of protein, as in our studies, these workers used a diet supplementing corn with casein or peas to raise the protein level. It is possible that this procedure accentuates the imbalance of tryptophan by supplying relatively more of the other two principal limiting amino acids in corn, lysine and isoleucine. Since tryptophan serves as a precursor of niacin, it would have the effect of lowering the relative niacin activity of the diet. This could be interpreted in *in vivo* experiments as a binding of niacin, whereas it is really an amino acid imbalance of the type described by Elvehjem and Krehl (1955). This proposed explanation does not account, however, for their failure to find a release of "bound" niacin in enzymatic digestion with papain, but this enzyme may be less effective for the purpose than the combination of pepsin, trypsin, and pancreatin used in this study.

REFERENCES

Anon. 1954. El maíz en la alimentación. Estudio sobre su valor nutritivo. Organización de las Naciones Unidas para la Agricultura y la Alimentación. Roma, Italia. FAO. Estudios sobre Nutrición No. 9.

Borrow, A., L. Fowden, M. M. Stedman, J. C. Waterlow, and R. A. Webb. 1948. A growth-retarding factor in maize bran. *Lancet* **1**, 752.

Bressani, R., and N. S. Scrimshaw. 1958. Lime-heat effects on corn nutrients. Effect of lime treatment on in vitro availability of essential amino acids and solubility of protein fractions in corn. *J. Agr. Food Chem.* **6**, 774.

Bressani, R., R. Paz y Paz, and N. S. Scrimshaw. 1958. Corn nutrient losses. Chemical changes in corn during preparation of tortillas. *J. Agr. Food Chem.* **6**, 770.

Carpenter, K. J., E. Kodicek, and P. W. Wilson. 1960. The availability of bound nicotinic acid to the rat. 3. The effect of boiling maize in water. *Brit. J. Nutrition* **14**, 25.

Chaudhuri, D. K., and E. Kodicek. 1960. The availability of bound nicotinic acid to the rat. 4. The effect of treating wheat, rice and barley brans and a purified preparation of bound nicotinic acid with sodium hydroxide. *Brit. J. Nutrition* **14**, 35.

Cravioto, R. O., G. H. Massieu, O. Y. Cravioto, and F. de M. Figueroa. 1952. Effect of untreated corn and Mexican tortilla upon the growth of rats on a niacin-tryptophan deficient diet. *J. Nutrition* **48**, 453.

Elvehjem, C. A., and W. A. Krehl. 1955. Dietary interrelationships and imbalance in nutrition. *Borden's Rev. Nutrition Research* **16**, 69.

Fiorentini, M., A. M. Gaddi, and A. Bonomolo. 1956. Esperienze di alimentazione con mais trattato con alcali. *Boll. soc. ital. biol. sper.* **32**, 793.

Jaffe, W. G., P. Budowski, and G. Gorra. 1950. El valor vitamínico de los maices venezolanos. *Arch. venezolanos nutric.* **1**, 367.

Kodicek, E. 1960. The availability of bound nicotinic acid to the rat. 2. The effect of treating maize and other materials with sodium hydroxyde. *Brit. J. Nutrition* **14**, 13.

Kodicek, E., R. Braude, S. K. Kon, and K. G. Mitchell. 1956. The effect of alkaline hydrolysis of maize on the availability of its nicotinic acid to the pig. *Brit. J. Nutrition* **10**, 51.

Koeppe, O. J., and L. M. Henderson. 1955. Niacin-tryptophan deficiency resulting from imbalances in amino acid diets. *J. Nutrition* **55**, 23.

Krehl, W. A., C. A. Elvehjem, and F. M. Strong. 1944. The biological activity of a precursor of nicotinic acid in cereal products. *J. Biol. Chem.* **156**, 13.

Krehl, W. A., L. J. Teply, and C. A. Elvehjem. 1945a. Corn as an etiological factor in the production of a nicotinic acid deficiency in the rat. *Science* **101**, 283.

Krehl, W. A., L. J. Teply, P. S. Sarma, and C. A. Elvehjem. 1945b. Growth-retarding effect of corn in nicotinic acid-low rations and its counteraction by tryptophane. *Science* **101**, 489.

Krehl, W. A., L. M. Henderson, J. de la Huerga, and C. A. Elvehjem. 1946a. Relation of amino acid imbalance to niacin-tryptophane deficiency in growing rats. *J. Biol. Chem.* **166**, 531.

Krehl, W. A., P. S. Sarma, and C. A. Elvehjem. 1946b. The effect of protein on the nicotinic acid and tryptophan requirement of the growing rat. *J. Biol. Chem.* **162**, 403.

Laguna, J., and K. J. Carpenter. 1951. Raw versus processed corn in niacin-deficient diets. *J. Nutrition* **45**, 21.

Massieu, G., O. Y. Cravioto, R. O. Cravioto, J. Guzmán G., and M. de L. Suárez Soto. 1956. Nuevos datos acerca del efecto del maíz y la tortilla sobre el crecimiento de ratas alimentadas con dietas bajas en triptofano y niacina. *Ciencia Mex.* **16**, 24.

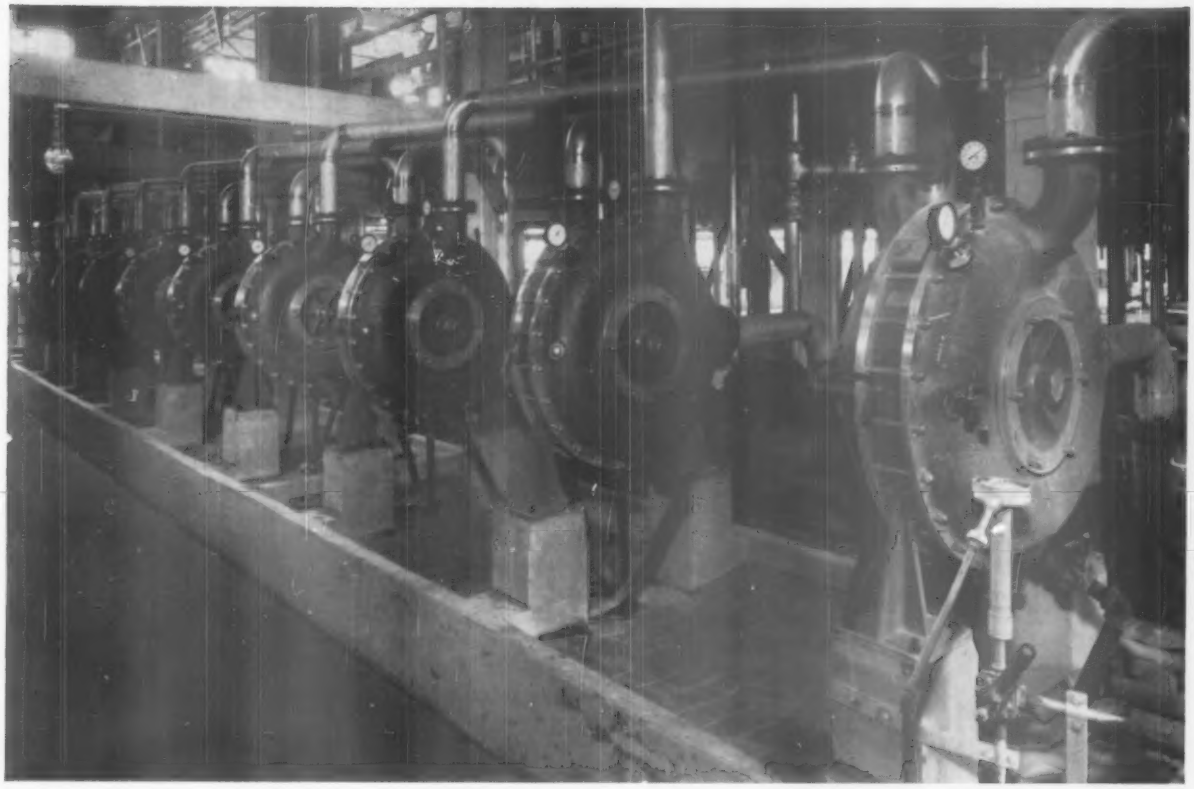
Pearson, W. N., S. J. Stempfel, J. S. Valenzuela, M. H. Utley, and W. J. Darby. 1957. The influence of cooked vs. raw maize on the growth of rats receiving a 9% casein ration. *J. Nutrition* **62**, 445.

Squibb, R. L., J. E. Braham, G. Arroyave, and N. S. Scrimshaw. 1959. A comparison of the effect of raw corn and tortillas (lime-treated corn) with niacin, tryptophan or beans on the growth and muscle niacin of rats. *J. Nutrition* **67**, 351.

Sweeney, J. P. 1951. Report on chemical method for nicotinic acid. *J. Assoc. Offic. Agr. Chemists* **34**, 380.

Sweeney, J. P., and W. P. Parrish. 1954. Report on the extraction of nicotinic acid from naturally-occurring materials. *J. Assoc. Offic. Agr. Chemists* **37**, 771.

Woolley, D. W. 1946. The occurrence of a "pellagragenic" agent in corn. *J. Biol. Chem.* **163**, 773.



Final separation and solubles washing is accomplished in this 9-stage DorrClone® system. Each of these clam-shell type separators contains hundreds of manifolded cyclone units.

HOW PENICK & FORD PRODUCES TOP-QUALITY STARCH WITH DORR-OLIVER EQUIPMENT

stages of continuous process include separation, concentration, clarification, degritting, washing, straining

Exceptionally pure starch is produced by Penick & Ford, Ltd. using a starch-gluten mixture derived from corn.

"Practically runs itself"—The separation process incorporates Dorr-Oliver equipment and "practically runs itself." Six major operations are performed by this system. Every detail is aimed toward high reliability to insure continuous operation. DorrClone separators, for example, fit perfectly into the picture because they are inherently reliable . . . contain no moving parts. Clarification of middlings product is carried out in Dorr-Oliver's new high-speed Model B-20 Merco centrifuges. Degritting of underflow from primary mercos takes place in a 20-unit two-stage P50A DorrClone system using large porcelain cyclones. Extra protection is provided by Merco® Rotary Strainers which remove tramp oversize particles. The system is carefully designed and instrumented to give maximum control of the starch product.

This modern plant is an example of accomplishment in food technology. Separation of a starch suspension is only one of a wide range of food and pharmaceutical separation problems you can solve with Dorr-Oliver equipment. If you'd like detailed information on our products—or assistance on a specific separation problem—drop a line to the Food & Pharmaceutical Division nearest you. Dorr-Oliver Incorporated, Stamford, Conn., 813 Merchandise Mart, Chicago, Ill., or 2900 Glascock St., Oakland, Calif.

AT THE CHEM SHOW—DORR-OLIVER BOOTH 531

DORR-OLIVER

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

FRITZSCHE IS BIG IN VANILLA!

Special Bulletin to Big Vanilla Buyers:

FRITZSCHE PURE VANILLA SINGLEFOLDS AND TWOFOLDS NOW PRODUCED IN UNLIMITED QUANTITIES....ORDER FROM 500 GALLONS UP ....PURITY INSURED BY CHROMATOGRAPHIC PROOF....SEND FOR FREE SAMPLE AND ATTRACTIVE FOLDER TODAY!

Send for FREE SAMPLE Today!

Flavor Division
Fritzsche Bros. Inc.
76 Ninth Ave.
New York 11, N. Y.

Please send me **FREE** 2 oz. sample of the Vanilla checked below, together with the folder—"What's different about Fritzsche Vanilla?"

- ☐ Pure Vanilla Singlefold Mexican No. 35250
- ☐ Pure Vanilla Singlefold Bourbon No. 35020
- ☐ Pure Vanilla Singlefold Special No. 35030
- ☐ Pure Vanilla Twofold Mexican No. 35280
- ☐ Pure Vanilla Twofold Bourbon No. 35248
- ☐ Pure Vanilla Twofold Special No. 35251
- ☐ Pure Vanilla Twofold No. 31373

Name.....

Company.....

Address.....

City..... **State**.....

F T OCT 1961

(Continued from page 19 preceding technical section)

1) Begins with packaging requirements (administrative, marketing, and technical) and leads into materials likely to be compatible with these requirements. Of particular help are tables listing the comparative physical and chemical properties of all commercially available packaging materials. An entire section is devoted to adhesives and tapes. Also included is a survey of current packaging practices drawn from the experience of 86 major companies.

2) Describes packages as to type and includes foamed plastic containers, blister packaging, packaging in aerosols, and variations of conventional metal cans, paperboard cartons, and glass containers. Tables on characteristics of molded and sheet plastics provide a useful guide.

3) Describes the machinery of packaging, again covering a very broad field from electronic counting equipment to case loaders and sealers. A table categorizes filling machines according to the physical nature of the products handled, providing information on speed range, type of container best suited for a given machine, and fill range capacity.

4) Describes merchandising considerations. There are short articles on basic design consideration, effective illustrations, and principles of using color.

5) Includes shipping and industrial packaging and describes such things as corrugated containers, steel and fiber drums, and wire-bound containers. Also included are two charts: one on the properties of selected cushioning materials; the other on sources of shipping regulations.

6) Devoted to an extremely useful buyers directory. It has an efficient cross-section reference whereby sources of supply can be located by referring to a particular item or service; a separate section lists suppliers and addresses alphabetically.

The industry could probably be served just as adequately if the book were issued every two years instead of annually. The basic technology of packaging materials and the basic machinery of packaging are not subject to rapid change.

C. P. Bolton

THE TECHNOLOGY OF WINE MAKING. M. A. Amerine Ph.D., and W. V. Cruess Ph.D. pp. XIII + 709. Avi Publishing Co., Westport, Connecticut. 1960.

The publication in English of a new book on wine making is always an important event, and when the book is written by two such well-known authorities as Professors Amerine and Cruess, it is likely to be sought after with eager anticipation by a large number of readers. These readers are not likely to be disappointed with "The Technology of Wine Making."

As pointed out by the authors, this book can be considered in some aspects as a third edition of "The Principles and Practice of Wine Making," by W. V. Cruess, published in 1947. However, the considerable advances made in the subject during the intervening years have necessitated a complete rearrangement of the text and the inclusion of a vast amount of new data, so that a change of title is fully justified.

The book is divided into twenty chapters and opens with an excellent series of brief sketches of the chief wine-producing regions of the world, their wines, and their methods. A critical discussion of the characteristics of American wine types should be of considerable interest to winemakers not only in the U. S. but also in other non-European wine-producing countries. Other chapters deal with the composition of grapes, the molds and yeasts of importance to wine makers, the chemistry of fermentation, and the design, equipment, and operation of the winery. Separate chapters deal with the production of each of the chief types of wine made in California. Each of these chapters is largely complete in itself, and although this arrangement has resulted in some repetition of certain sections of the text and of the bibliographies that follow each chapter, it is probably justified for ready reference. Directions for making various wines refer primarily to California practices, but the methods used for making sherry, sparkling wines, vermouth and fruit wines in other countries are also described in some detail. Wine making in the eastern United States receives a separate chapter. Then follow chapters devoted to spoilage of wine, brandy production, by-products, and the evaluation of wines and brandies by sensory, microscopic, and chemical methods. The final chapter, "Legal Restrictions on the Wine Making." is intended primarily for readers in the U. S. but contains much information of interest to overseas readers.

The book fulfills a need for an up-to-date text in English on all aspects of wine making. Indeed there are few if any modern books in any language that cover the whole subject as this one does. The subject matter reflects the long and wide experience of the writers and also the extensive researches in this field at the University of California.

The authors have taken considerable pains to make the book really up to date and have at the same time succeeded in producing a work that is both interesting and easy to read.

Criticisms of the book that occur to this reviewer concern a few matters of detail only. Many overseas readers may be surprised that "free SO_2" does not receive greater attention in discussions of the use and rôle of SO_2. The bibliographies are very extensive and undoubtedly of great value as a source of references, but the student and the winery technician would probably appreciate a more critical assessment of the relative value of the references quoted. The index is on the whole good, but in some respects confusing. For some subjects over thirty different page entries are listed, and for at least one subject over fifty such entries appear. Greater subdivision of some of the subjects and printing the more important page entries in heavy type would render the index more useful.

Very few typographical errors were found considering the magnitude of the publication, and most of those noticed are so obvious as to be unlikely to cause any confusion. However, the statement (p. 144) that *S. cerevisiae* var. *ellipsoideus* can be distinguished

New!
Improves
Chocolate!

INTENSITOL
Synthesized Chocolate
Flavor Intensifier

Completely new development! Heretofore unobtainable flavor aromatics, produced in our laboratories, will dramatically improve the deliciousness of your chocolate flavored products.

In conjunction with cocoa powder or chocolate liquor, INTENSITOL restores the delicate volatile flavor aromas universally lost during manufacturing processes. This new synthesized chocolate intensifier in your product assures the ultimate in *flavor's richness, taste and aroma.*

INTENSITOL available in
LIQUID
or SPRAY DRIED
(encapsulated)

Send for samples, prices & information.

Better Flavors for Better Products
FLAVOREX CO., INC.
302 S. CENTRAL AVE., BALTIMORE 2, MD.

from *S. cerevisiae* by inability to ferment melibiose, is contrary to the usually accepted description of these yeasts.

The book is very attractively produced and liberally illustrated with a wide range of fine photographs from many countries. It should have wide appeal for wine makers and winery technicians in English-speaking countries. It will also be an admirable text for college students in enology.

J. C. M. FORNACHON

ADVANCES IN FOOD RESEARCH, Vol. X. Eds: C. O. Chichester, E. M. Mrak, and G. F. Stewart. Academic Press, New York, March 1961, $12.00.

As is usual in these volumes, a variety of topics are covered. Most of the authors are well known, being recognized authorities in their fields. The reviews are all excellent of their kind, well arranged, and, within their avowed limits, thorough. It seems a pity that the one on soy sauce was restricted to the chemistry of aroma and flavor; compared with that on sauerkraut, it seems unbalanced. Where a review is requested on a special subject not likely to be reviewed again for some time, it is surely desirable to have it as comprehensive as possible. Only one important omission has been noticed, though there might be others: in discussing ascorbic acid synthesis, Biale should have referred to the much more important later publications of Mapson and colleagues, instead of their 1954 paper.

The coverage as a whole is skillfully divided between the general and the particular. Representative of the former are the articles on food science and on protein chemistry; such topics have a wide interest. But the more particular articles, like those on the water-binding of meat, have their value too; for example, to this reviewer, who has been interested in yeasts isolated from soy sauce, it is most helpful to find here an article on this, to him, most unfamiliar product, reviewing much material not easily accessible otherwise. Animal, plant, and fish foods are all represented; and the scientific besides the technological viewpoints.

The editors have chosen to emphasize "the rapidly maturing field of food science." Pride of place is accordingly given to Joslyn's status report on food research, which is in effect a well-documented plea for a more integrated and fundamental approach that will justify the term *science* as distinct from *technology.* Nevertheless, the impression left by this volume, as by earlier ones, is that food research has hitherto mostly consisted of simple fact-finding: identification of constituents and their relation to properties of the food; or the mere description of effects of cold and heat or other forms of processing. Such information has an obvious value because it is immediately applicable to the problems of industrial operations. But from this mass of information, much of it unconnected, is emerging a realization that, to control or to change such factors intelligently, we

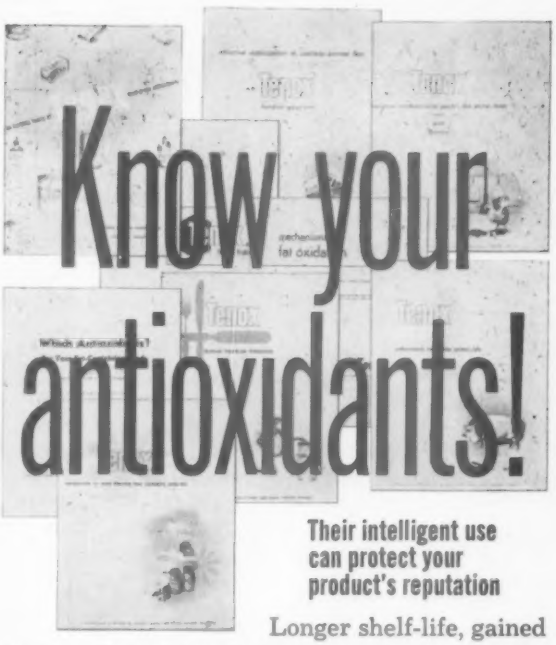
must have more fundamental and systematic knowledge of how they themselves are influenced; that is to say, of the biological reactions of the relevant plants, animals, and associated microorganisms. To take examples from the text, can we discover what determines the functional properties of proteins from different sources, and how to influence them in the food organism? Can we learn to manipulate the starch or pectin content of potatoes, or to breed out undesirable polyphenols or enzymes? Can we elucidate the nature of the fermentation processes in soy sauce, so as to produce the desired end products and avoid the undesirable? It is no coincidence that, after an epoch in which food research has been mainly technological, this should be a time when emphasis is beginning to be laid on food science as distinct from technology.

The importance of the fundamental approach implicit in the concept of food science is as well illustrated by what is missing as by what is included. From the article on potato chips, for instance, it is plain that more fundamental knowledge is now required. Texture is shown to be related to content of starch and of calcium pectinate; enzymic blackening to phenol content and peroxidase; browning during frying to reaction between reducing sugars and amino-acid fraction. But, save for the well-known influence of storage temperature on sugar content, we are still largely ignorant of what controls such factors and are consequently unable to influence them in desired ways by practical treatments. Similarly, the review on paralytic shellfish poisoning indicates that the most serious lack at present is fundamental: precise knowledge of the nature of the poison itself. Without this it is difficult to decide why particular species of shellfish are more dangerous than others or to develop specific therapeutic measures against the poisoning, and impossible to develop a specific test for the toxin or to identify with certainty the plankton microorganisms whose ingestion is believed to cause its accumulation in shellfish. That the fundamental deficiencies are plain to some of the contributors is apparent in the admirable "summaries of research needed" that conclude their articles.

The over-all quality of the publication is marred by several obvious lapses in editing detail. These are trivialities that do not detract from the value of the text, however. More serious are the formulae in Table VI of the third article, where, besides being confusingly overcrowded, some are written in a manner giving misleading indications of the chemical linkages. Let us, however, conclude with matters of more significance.

The editors, in their foreword to Vol. 1, wrote that the series is offered to fulfill "the need for co-ordination and integration of food research" and "to provide a medium in which every phase of food research may be exhaustively and critically reviewed." These objectives have been handsomely attained. The ten volumes provide a mine of well-coordinated information not available anywhere else, and are quite indispensable to all serious workers in food research.

M. INGRAM



Their intelligent use can protect your product's reputation

Longer shelf-life, gained through the intelligent use of antioxidants, has often spelled the difference between success and failure in marketing a food product. Key to the intelligent use of antioxidants is an understanding of their function. An easy way to obtain that understanding is through the following pieces of literature:

- **Tenox—Eastman food-grade antioxidants**
- **The Eastman family of Tenox food-grade antioxidants**
- **Which antioxidants for your fat-containing foods?**
- **Tenox antioxidants for more effective food packaging materials**
- **Tenox antioxidants for edible animal fats**
- **Effective stabilization of inedible animal fats with Tenox**
- **Tenox feed-grade antioxidants for poultry and animal feeds**
- **Tenox antioxidants for the fishing industry**
- **Mechanisms of fat oxidation**

Eastman manufactures all the principal types of food-grade antioxidants in use today. We can, therefore, suggest without bias the most effective antioxidant for your product. For any of this literature about antioxidants, write to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

Tenox Eastman food-grade antioxidants

1962 Food Technology Industrial Achievement Award Winner to Be Named Soon

Members of the Institute of Food Technologists are invited to submit their choice now, for the 1962 Food Technology Industrial Achievement Award. The simple procedure consists of sifting out in your mind, all recent products or processes which could be considered worthy of the honor—either within or outside of your Organization or Institution.

Next step is determining whether or not the product or process qualifies for the Award. Does it offer a significant advance in the application of Food Technology to food production? Has it been successfully applied in actual commercial operation for at least six months, but not over four years from this month?

This should eliminate several, and when your decision is final, submit your Nomination in letter form including the following:

A. Name of Company or Institution
B. Name of Product and/or Process
C. Description of Product or Process
D. Statement or reason for considering this a meritorious achievement.
E. Statement listing individuals chiefly responsible for the achievement and their individual contributions
F. Statement indicating the time and extent of commercial utilization

Nominations must be limited to an absolute maximum of three single-spaced typewritten pages.

The Company or Institution winning the Food Technology Industrial Achievement Award will be presented a bronze Plaque plus, insofar as possible, public recognition at the time of presentation during the 22nd IFT Annual Meeting at Miami Beach in 1962. Furthermore, the individual(s) chiefly responsible for the product or process, either through basic research or development, will each be presented with an engrossed plaque and be given public recognition for his achievements.

While the Award is available each year, such high standards of merit are expected that the following is included in the rules governing it: "It is, therefore, not anticipated that a suitable meritorious subject will be found every year. It is accordingly the prerogative of the Awards Jury to pass or postpone the Award whenever in the judgment of the Jury none of the nominations fully meet the high standards of achievement for which this Award is established."

Upon completion of your Nomination, submit it to:

INSTITUTE OF FOOD TECHNOLOGISTS
176 West Adams Street
Chicago 3, Illinois

DEADLINE FOR RECEIPT—December 1, 1961

Coming Events

1961

October 10	Joint meeting of the Midlands Section of the Society for Analytical Chemistry and the Birmingham and Midlands Section of the Royal Institute of Chemistry, the University, Edgbaston, Birmingham 15.
October 13	Joint meeting of Great Lakes Section, IFT and the Nutrition Foundation, Michigan State University, East Lansing, Michigan.
Oct. 15–18	National Association of Food Chains, Palmer House, Chicago, Illinois
Oct. 18–20	National Packaging Forum of Packaging Institute, Biltmore Hotel, New York City
Oct. 16–19	Second International Congress of the International Organization for Vacuum Science and Technology, Washington, D. C.
Oct. 19-20	Symposium on Freeze-drying of Foodstuffs, Borough Polytechnic, Borough Road, London, S.E. 1, England
Oct. 19-20	European Federation of Chemical Engineering Symposium on Food Technology, Frankfurt/Main, Germany
Oct. 19–20	Symposium on Freeze-drying, London
Oct. 23–28	First Inter-American Congress of Chemical Engineering, San Juan, Puerto Rico (write Institute of Chemical Engineers of Puerto Rico, P. O. Box 47, Rio Piedras, Puerto Rico)
Oct. 24–27	American Dietetic Association, Jefferson Hotel, St. Louis
Oct. 26–27	Europenn Symposium "Food Technology," Frankfort, Main, Germany.
Oct. 28–31	National Automatic Merchandising Assn. Convention and Exhibit, Chicago, Illinois
Nov. 5–8	National Frozen Food Association, Bal Harbour and Americana Hotels, Miami Beach
Nov. 6–10	National Hotel Exposition, Coliseum, New York City
Nov. 6–11	4th General Assembly of the Experimental Center for Refrigeration, Valencia, Spain
Nov. 12–15	Air Conditioning and Refrigeration Institute, Homestead Hotel, Hot Springs
Nov. 15	British National Association of Wholesale Distributors of Frozen Foods—Annual Lunch, Trocadero, London
Nov. 27–Dec. 1	28th Exposition of Chemical Industries, New York Coliseum
Dec. 1-3	National Automatic Merchandising Assn. Western Conference and Exhibit, Los Angeles, California
Dec. 5–7	Annual Dry Bean Research Conference, Brown Palace Hotel, Denver, Colorado.

1962

Feb. 9–11	Institute of American Poultry Industries' 33rd Annual Fact Finding Conference; Municipal Auditorium, Kansas City, Missouri
May 10–12	International Symposium on Food Protection, Department of Dairy and Food Industry, Iowa State University, Ames, Iowa
May 23–26	**Twenty-third Annual Meeting of the Institute of Food Technologists, Cobo Hall, Detroit, Michigan**
June 10–14	**Twenty-second Annual Meeting of the Institute of Food Technologists, Fontainebleau Hotel, Eden Roc Hotel, Miami Beach, Florida**

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, P. O. Box 164, Davis, California, notices of annual or national meetings of interest to food technologists.

PROTECT EDIBLE OILS AGAINST OXIDATION AND RANCIDITY WITH

AIRCO GAS SPARGING

EFFICIENT, LOW COST, EASY-TO-INSTALL

The deterioration of commercial edible oils during manufacture and storage can now be prevented by simple, inexpensive sparging with Airco nitrogen. If atmospheric oxygen is effectively excluded after deodorization and until the product is sealed in its final container, the shelf life and quality of edible and essential oils can be preserved.

Airco sparging with nitrogen is an excellent method for flushing out oxygen from other oxygen-sensitive liquids such as citrus juices, essential oils, wines, etc.

Other Airco Sparger Uses

Fluffing: The fluffing of such products as mayonnaise, salad dressings, shortening, peanut butter, ice cream, etc., is accomplished by the super-saturation with minute gas bubbles.

Controlled Fermentation: Sparging with oxygen, nitrogen or CO_2 offers a simple means of controlled fermentation.

Light Carbonation: The effervescence of wines and other beverages is simple and practical with an Airco Gas Sparger.

AIRCO® **AIR REDUCTION SALES COMPANY**
CUSTOMER SERVICE LABORATORY
1400 East Washington Ave., Madison 10, Wisconsin

The Unique Airco Gas Sparger: This clean, simple, compact unit does the job during the process flow with no disturbance of existing equipment. It is easy to install, low in price, efficient. For further information about Airco Gas Sparging of your products—fill out this coupon—mail it today.

AIR REDUCTION SALES COMPANY
Customer Service Laboratory
1400 East Washington Ave., Madison 10, Wisconsin

Please send me the following technical bulletins: 1. General principles of sparging. 2. Edible oils. 3. Citrus concentrates.

NAME _____
TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

IFT News

National

IFT COMMITTEE ON QUALITY CONTROL OF FOOD PRODUCTS

On May 8, 1961, a meeting of this Committee was convened by the Chairman, Mr. Filice, at 3:15 P.M. in the Statler Hilton Hotel, New York City. The following were in attendance:

Bruno Filice, Chairman, Filice & Perelli Co.
Stanley Hotchner, Secretary, American Can Co.
Lewis Beem, Gerber Products Co.
Harry Couden, Safeway Stores Inc.
Dr. Richard Guyer, Continental Can Co.
William Hoover, Corn Industries Research Foundation
Dr. Amihud Kramer, Univ. of Maryland
Abe Mittler, California Packing Corp.
Dr. Gordon Rowe, Univ. of California
Dr. F. Miles Sawyer, Univ. of Massachusetts
John Yeatman, U.S.D.A. Agricultural Marketing Service

The meeting followed the agenda distributed on April 12.

1) The Chairman called upon Dr. Kramer to make a report on his study of the feasibility of suggesting sound standards. Dr. Kramer reported that he had been in correspondence with Past-President Hutchings on the propriety of suggesting sound standards. Dr. Hutchings agreed that the Committee's work should not be devoted to specific standards but rather should seek to set up the criteria that are required for sound standards. Dr. Kramer suggested a two-step program: first, to seek to establish a set of criteria for promulgation and, second, to survey the existing standards to see if they conform with the criteria. In this connection, Mr. Filice pointed out that the new California Weights and Measures Code had been endorsed by the Northern California Section of the Institute. Dr. Kramer was of the opinion that it should be possible to set up the criteria for a report to this Committee at its next meeting, in 1962. It was agreed that two subcommittees geographically separated would be appointed to work independently on these criteria.

Mr. Filice appointed Drs. Guyer and Kramer to head the subcommittees and to select their own committee members. It was agreed among those in attendance that we should be careful not to set up absolute tolerances but should aim for a list of basic requirements in establishing standards. The long-range intent of this work is to try to avert the establishment of differing standards for any particular product by each state or regulatory agency.

2) The proposal for sponsoring a short course in SQC methods for the Food Industry in the Midwest area was discussed. The general opinion was that many short courses have been given throughout the country and that there seemed no immediate need for the Committee to undertake this kind of work at this time. It was agreed, however, that the Committee would make itself available to assist any local group planning such a course with material and talent. Drs. Buck and Rowe were asked to undertake this activity as well as coordinating SQC material with the new National Committee concerned with section programming.

3) This topic was publicity for the Committee's activities within IFT. Mr. Filice reported that Dr. Stewart, the new editor of the Institute's publications, has agreed to giving the Committee space in Food Technology. Mr. O'Neal will continue as our contact man and his address is: Mr. Rolie O'Neal, Spice Islands Co., 100 E. Grand Ave., South San Francisco, California. The intent is to try to obtain space in each issue reporting some activity of the Committee or a new application of SQC in the food industry.

4) On the subject of plans for the 1962 Annual Meeting Program, Mr. Filice had contacted Dr. Betty Watts, Program Chairman for the 1962 Convention, who advised that she will welcome the assistance of this Committee. Dr. Kramer suggested we should think in terms of a coordinated one-day program with one-half day devoted to statistical quality-control methods and one-half day to instrumentation.

Mr. Filice appointed a sub-committee of Mr. Beem (Chairman), Dr. Sawyer, Dr. Buck, and Mr. Hoover to develop the Committee's plans and work with Dr. Kramer, Mr. Filice, and Miss Sather, who will be the Committee's contact on the National Program Committee.

5) The last item of business was a motion to request $50.00 from the Institute to establish a revolving fund to cover the Committee's mailing expenses. The motion was passed without opposition.

Mr. Filice reported that Dr. Schultz had reappointed him Chairman of this Committee for the ensuing year. With agreement of those in attendance, Mr. Filice reappointed Mr. Hotchner as Secretary.

STANLEY HOTCHNER, Secretary

International

KEFFORD GIVEN AUSTRALIAN IFT AWARD

J. F. Kefford, Senior Principal Research Officer of the C.S.I.R.O., was presented with the Institute of Food Technologists' 1961 Australian Award at this year's convention, at Lorne, Victoria. The IFT Australian award was established a few years ago to encourage and recognize achievement in food technology in Australia.

Kefford is a Fellow of the Royal Australian Chemical Institute, a foundation member of the IFT in Australia, a past chairman of the IFT Australia Northern Section, one of the three Honorary Associate Members of the Food Technology Association of New South Wales, and a member of the Scientific and Technical Commission of the International Federation of Fruit Juice Producers. His main fields of interest are canning technology, the chemistry of processed foods (particularly citrus), and control of quality in foods.

People

J. Arthur Meeter, vice-president and general manager of Meeter Bros. & Company, Union Grove, Wisconsin, has been elected president of the National Kraut Packers Association. He succeeds **Lon Flanigan, Jr.,** of Seneca Kraut & Pickling Company, Geneva, New York, who had served four consecutive one-year terms as president. **Elbert Garlock**, of Empire State Pickling Company, Phelps, New York, was elected vice-president.

The appointment of **Haskell Needle** as Director of Research and Development for Basic Food Materials, Inc., Vermilion, Ohio, was announced recently. In his new post, Mr. Needle is responsible for BFM's new product program. Mr. Needle's background is in the fields of starches, sugars, syrups, proteins, meats, fats, and enzyme technology. A graduate of the Massachusetts Institute of Technology with both B.S. and M.S. degrees, Mr. Needle has been a Research Associate in the Department of Food Technology at M.I.T., a Technical Director for large food processing firms, and, for two years, an independent consultant to the food industry.

Haskell Needle

Dr. O. J. Kahlenberg has been appointed Director of Research for Seymour Foods, Inc., Topeka, Kansas. Before joining the Seymour firm, Dr. Kahlenberg was Professor of Poultry Husbandry at Missouri University. Prior to that he was Director of Research and Products Development for the F. M. Stamper Company, Moberly, Missouri. Earlier he was Director of Research for the National Egg Products Association; Chemist-in-Charge of the National Laboratory of the Dairy and Poultry Inspection and Grading Division of the U. S. Department of Agriculture; associated with the Borden Biological and Chemical Laboratories in New York; and with the Pennsylvania State University Nutritional Research staff. Dr. Kahlenberg received his B.S. degree in Agriculture at the University of Wisconsin, his M.S. degree at Rutgers University and his Doctorate from Cornell University.

Continental Baking Company announces the appointment of **Dr. Robert R. Baldwin** as research supervisor for its Research Laboratories in Rye, New York. He will be concerned primarily with the analytical chemistry of foods. Dr. Baldwin is former laboratory director of the General Foods Corporation, having served with the organization for 15 years directing research on the fundamental chemistry of foods. He was graduated from DePauw University, Greencastle, Indiana, and received his Ph.D. from Iowa State University, Ames, where he also taught.

R. R. Baldwin

Dana D. Downing has joined Diamond Crystal Salt Company as assistant manager of industrial sales. Before receiving the appointment, Downing was food technologist at Clinton Corn Processing Company, a division of Standard Brands, Inc. A native of New York state, he holds bachelor's and master's degrees in food technology from the University of Georgia.

D. D. Downing

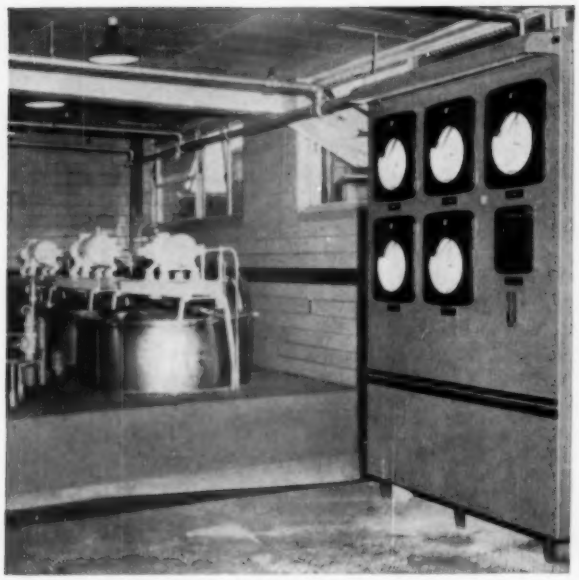
Foster D. Snell, Inc., has appointed **William E. Chesney** Director of Laboratories for its Baltimore Labs Division, Baltimore, Maryland, formerly known as Crippen Labs Division. Until his association with Baltimore Laboratories, Mr. Chesney was a technical consultant in the fields of microbiology, biochemistry, and product development. He also worked in basic microbiological research at the Institute for Cooperative Research, Johns Hopkins University, and was employed by U. S. Industrial Chemical Corporation, where, as a bacteriologist, he worked on research and development activities relating to the production of vitamins and antibiotics.

The appointment of **Richard Y. Kitsuse** as Director of Research and Development was recently announced by F. Ritter & Company. Mr. Kitsuse completed his graduate and post-graduate studies at the University of Illinois.

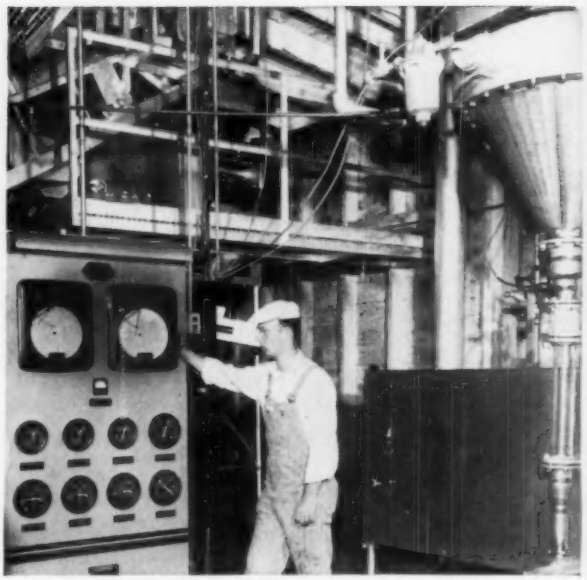
R. Y. Kitsuse

Daniel S. Cvacho has been promoted to the newly created position of director of packaging engineering for Reynolds Metals Company. In his new capacity, Mr. Cvacho will be responsible for the design and installation of packaging machinery and equipment, either for use by Reynolds or by the firm's packaging customers. A native of Richmond, Mr. Cvacho studied mechanical engineering at Virginia Mechanics Institute. He joined Reynolds in 1944, and successively

D. S. Cvacho



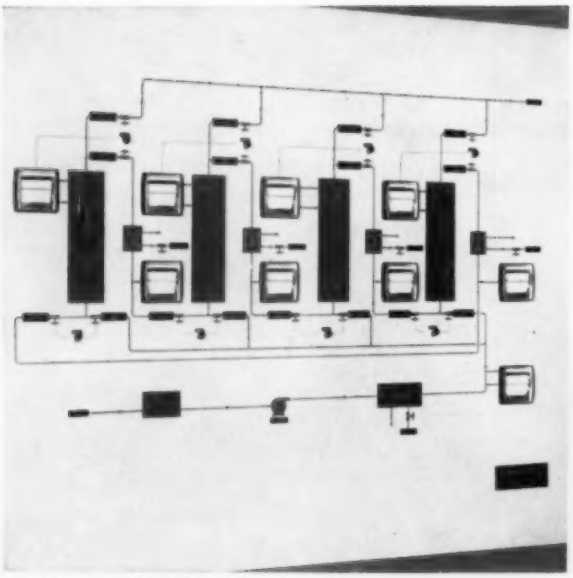
MILK PROCESSOR – TENNESSEE Foxboro 6-instrument cabinet controls milk fore-warmer temperatures with Dynalog* Electronic Instruments. **2-, 4-, or 6-instrument cabinets** can be installed individually, or in combination — provide complete centralized control of any food process, large or small.



FOOD PACKER – CALIFORNIA Automatic control of process evaporator is easily handled from the Foxboro cabinet. Integrated control system, specifically designed for the process by Foxboro, assures perfect quality and flavor of concentrate. **Grouping of related controllers and indicators** results in easier operation, simpler maintenance.

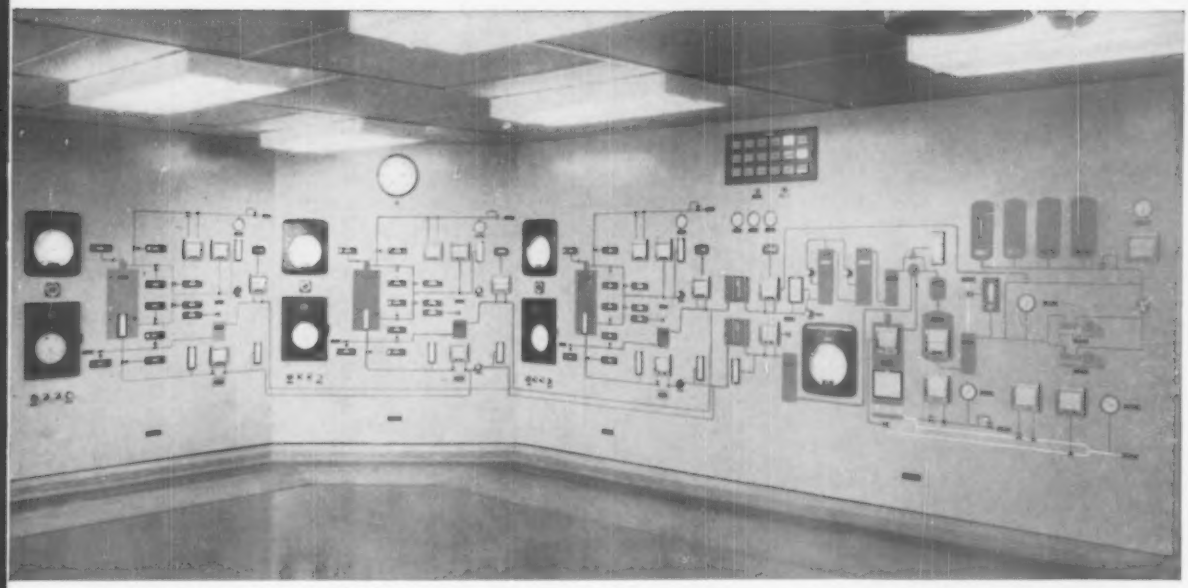
For any food plant –

an integrated Foxboro



COFFEE PROCESSOR – NEW YORK This centralized control panel has its graphic diagram painted on a formica plastic background, permitting **easy modification of the diagram** should process changes occur. **Painted formica panels** are only one of several types of graphic control panels available from Foxboro.

BREWERY IN MEXICO Complete Foxboro centralized control system simplifies operation of rice and mash cookers, hot and cold water tanks, lauter tubs, and brew kettles. Air tubing is neatly formed and fitted to permit easier servicing and maintenance. System was designed and assembled in Foxboro, Mass. — **shipped in sections for installation in Mexico.**



VEGETABLE OIL REFINERY — ILLINOIS Complete control of hydrogen generation units is accomplished from this graphic panel. Small-case Consotrol* Recording-Control Stations are installed right in the process diagram — linked to their appropriate measurement and control points by colored lines — resulting in easier operation and better process supervision. **All back-of-panel connections** are plainly marked for quick and easy identification.

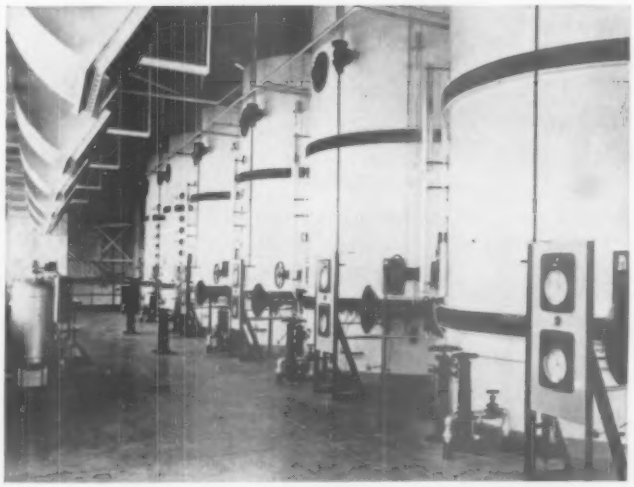
for every food process

Packaged Control System

Complete packaged control systems providing centralized operation from one convenient location! It's the trend that's streamlining the efficiency of food plants today.

Foxboro custom-engineered packaged control systems make it easy. Years of application engineering experience insure that instruments are exactly suited to your process — shipped already mounted in cabinets or panels, completely piped and wired. Only power and process connections are needed to put them into operation. This simplified installation, plus the operating convenience and low maintenance of these custom-engineered control systems keep cost at a minimum.

Full details on Foxboro Packaged Control Systems are now available in a new illustrated bulletin. It contains complete information on the design and construction of cabinet and panel units . . . as well as Foxboro's rigid requirements for high quality piping and wiring. Write for it today. The Foxboro Company, 3510 Norfolk St., Foxboro, Massachusetts, U.S.A. *Reg. U.S. Pat. Off.



SUGAR PLANT — CALIFORNIA Local control for these vacuum pans is provided by individual panels for better operator supervision. Heavy gauge steel panels protect instruments and accessories from accidental damage.

FOXBORO
REG. U.S. PAT. OFF.

INSTRUMENTATION FOR THE FOOD INDUSTRIES

served as project engineer, senior engineer, and division engineer for foil printing.

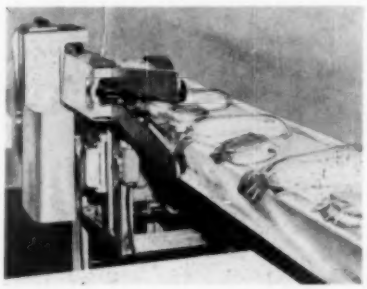
Industry News

Acquisition of Unit Packet Corporation, Wilmington, Massachusetts, has been announced by Diamond Crystal Salt Company. **Charles F. Moore,** Diamond Crystal president, said that the purchase price of $1,750,000 includes all patents, machinery, plants, and affiliates of the acquired firm, including manufacturing facilities at Wilmington and Montreal, Canada. Unit Packet manufactures fluted shaker-action packets for salt, pepper, and sugar; and disposable packets for salt and sugar substitutes, mustard, catsup, grated cheese, lemon flavoring, jellies, and A-1. Steak Sauce.

Packaging

A two-pound loaf pan with an interrupted vertical curl adaptable to closure has been added to Anaconda Aluminum's line of **bakery containers.** The new #438 IVC container (38-ounce .004-gauge pan) is for pound cake, marble cake, specialty breads, and deep-dish foods such as apple dumplings. Also being marketed is a new cheese-cake container identified as #572, with a capacity of 27 fluid ounces. It is available in .0035-gauge metal, and designed for bakery products as well as entrees of frozen and prepared foods. For further information write **Anaconda Aluminum Company,** P. O. Box 1654, Louisville 1, Kentucky.

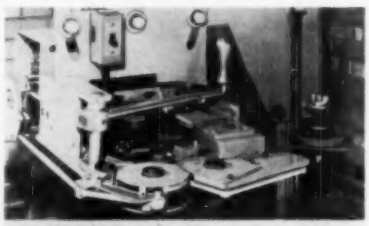
A new sanitary **bag sealing conveyor** for food-handling commissaries engaged in volume sandwich making is now being marketed by Mercury Industries. Incorporated in the stainless-steel conveyor is a

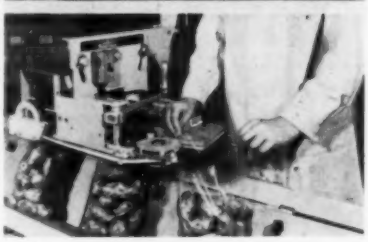


sealing device. The Mercury unit is designed to accommodate various sizes of bags without changes or adjustments. The traveling belt is a three-ply neoprene-impregnated 10-in.-wide food belt and moves at a variable speed of 15 to 30 fpm by ¼-hp motor. For further information write **Mercury Industries,** Hillsdale, New Jersey.

A new **rigid urethane packaging material,** Hewfoam, which is designed to provide a lightweight, moisture-resistant, temperature-insulating and highly shock-resistant package, is announced by H. E. Werner, Inc. Specifically intended for economical packaging and safe shipping of odd-shaped, fragile, or expensive products, Hewfoam also protects ordinary products against damage from temperature extremes during transport. Particularly, it is adaptable for office machines, bottled liquids, delicate instruments, laboratory supplies, perishables (such as pharmaceuticals), glass and chinaware, electrical appliances, radio and television parts, etc. Hewfoam's light weight makes packaging easier, faster, with less worker fatigue. It is furnished as a container with product spaces that conform to the shape of the product, which eliminates or minimizes "stuffing." Because of its light weight, it saves on shipping costs. Free descriptive literature is available without cost from H. E. Werner, Inc., 2990 Industrial Boulevard, Bethel Park, Pennsylvania.

An **automatic bag sealer** designed to seal up to 80 bags a minute has been introduced by Minnesota Mining and Manufacturing Company (3M). The new machine, said to be adaptable to all types of polyethylene bags and to many cellophane and cloth bags, features a closure device that adheres a pressure-sensitive tape seal around the closure of the bags. Called the "Scotch" brand S-605 Automatic Bag Sealer, the machine is designed for a wide variety of bagged products up to 10 lb in capacity. Price of the new sealer is $2,375, and the stand is priced at $212.50. All prices are f.o.b. delivered, and subject to change without notice. For further information write Dept. J1-2, 3M Company, 900 Bush Avenue, St. Paul 6, Minnesota.



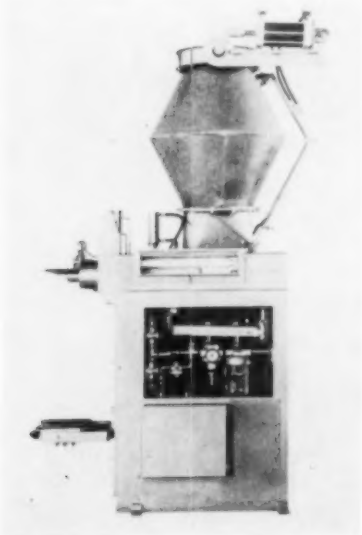


New ease, speed, and accuracy for packers of powdery, flaky, granulated or pelleted materials, are advantages announced for the new Stok-Aire **air-pressure packer** just introduced by H. L. Stoker Company. Other announced benefits include faster bag filling and tighter bags, with either valve or open-mouth bags or drums. The Stok-Aire also incorporates an electronic weighing system for true weight accuracy, with ¼ oz caus-

No, But She Knows What She Likes! Somehow she could never bring herself to try snails. But she's famous for her chicken fricassee and dumplings. Tasty food is important to her. To her? To everybody. The public stays stubbornly away from foods that miss on flavor. The public stays stubbornly loyal to foods that are flavored by Felton! Why? Because Felton works with all the standard ingredients of flavor plus one: creativity. This flavor creativity makes taste buds flower to their fullest satisfaction; develops steady customers, steadily growing sales. Send for the man from Felton. He'll put this creativity to work for you! Felton Chemical Company, Inc., 599 Johnson Ave., Brooklyn 37, N.Y.

Felton

ing actuation of an electronic sensing capacitor. The new unit is designed for 20 to 250 pounds packed weights. Full details of the Stok-Aire are illustrated in a two-color 4-page brochure available from the H. L. Stoker Company, P. O. Box 112, Claremont, California.



Equipment & Supplies

A new type of **continuous starch cooker** that will operate either full-time or respond automatically to process demands, has been developed by the Industrial Division, Corn Products Sales Company, 10 East 56th Street, New York 22, New York. It is said to be the first automatic starch cooker that allows the operator to select continuous or intermittent operation by pressing a button. It is capable of either partial or complete pasting (complete disruption) of starch granules. Advantages cited by the manufacturer include capability of providing absolute continuity of starch colloid properties when operating on an intermittent basis, and automatic features to assure uniform cooking, exact control of dilution water or modifying ingredients, and final composition of starch preparations. A series of accessory components to provide for automatic thermal or mechanical modification is available. The new unit occupies six sq. ft. of floor space. Price ranges from $300 to $3,000, depending on the need for accessory items such as modifying ingredient tanks, additional pumps, extra heaters, etc.

Soft-rubber attachments for **conveyor belts** are now available to cushion and cradle perishables without bruising, chafing, or rolling on either horizontal or inclined conveyors. These patented Peg-Flite units, in sizes to fit all standard conveyor belts, are designed to provide a tender but certain grip on tomatoes, peaches, apples, and other perishables that require careful handling. Units are individually installed in only 15 to 20 seconds, and can be spaced or grouped in patterns to suit any product or operation. Complete information is available from Holz Rubber Company, Inc., Lodi, California.

Two-way precision-engineered line **diverter valves**, manufactured in either cast iron or aluminum, are described in new literature by Systems Engineering and Manufacturing Company, Inc. The valves shown can be furnished in seven basic types, to operate either automatically or manually. They are designed to permit constant flow without change of velocity, and keep pressure loss at a minimum. Dimensional drawings and structural model information are included. Write Systems Engineering and Manufacturing Company, Inc., P. O. Box 7634, Houston 7, Texas.

Clearflo, a newly developed, low-cost, **transparent polyvinyl chloride tubing,** is now available from Newage Industries, Inc. It was developed to combat corrosion in the transmission of gases, acids, alkalis, petroleum products, sea water, and other active chemicals or materials. A food-grade formulation designed to handle delicately flavored substances is also available. Free samples of Clearflo and reinforced Clearflo tubings and specifications may be obtained by writing Newage Industries, Inc., 222 York Road, Jenkintown 46, Pennsylvania.

The Project-O-Scope, a new **projection microscope** introduced recently by the National Instrument Company, combines two precision instruments in one—a microscope that provides magnifications up to 1500×, mult with optional oil immersion objectives, and a microprojector. For further information, write National Instrument Company Inc., Baltimore 15, Maryland.

Education

Technical personnel and others connected with the Florida Citrus, Food, and Beverage Industries recently completed a six-day **course in Statistical Quality Control** (SQC) at the **University of Florida**

in Gainesville. The course was jointly sponsored by the National Canners Association, Washington, D.C., the University of Florida College of Agriculture and Florida Agricultural Extension Service, and the Florida Section of the IFT. Major topics covered were: 1) the problem of sampling; 2) statistical quality control; 3) what to do when the process or procedure being measured is out of control; and 4) analysis of case histories in the application of SQC to food processing. **Dr. Howard Stier,** Director of the Division of Statistic, National Canners Association, was head instructor. He was assisted by **Dr. A. E. Brandt,** Head of the Statistics Section, Agricultural Experiment Station; **Dr. Willard O. Ash,** Associate Professor of Statistics; and **Dr. R. A. Dennison,** Head of Food Technology and Nutrition Department, all of the University of Florida.

Literature

BOOKS

Biochemists' Handbook, Ed., Cyril Long. D. Van Nostrand Company, Inc., Princeton, New Jersey, $25.00.

Scientific Thinking and Scientific Writing, 1961, Martin S. Peterson. Reinhold Publishing Corp., 430 Park Ave., New York, N. Y.

Colorimetric Methods of Analysis, Volume IIIA, 1961, Foster Dee Snell, Cornelia T. Snell, and Chester Arthur Snell. D. Van Nostrand Company, Inc., Princeton, N. J., $12.75.

The Mites of Stored Food, Technical Bulletin No. 9, 1961, A. M. Hughes. Ministry of Agriculture, Fisheries and Food, Agents in U. S.: British Information Services, 45 Rockefeller Plaza, New York, 20, N. Y., $3.30.

Continuous Culture of Micro-organisms, 1961, papers read at a Symposium at University College, London, in 1960, Society of Chemical Industry, 14 Belgrave Square, London, S. W. 1, and The Macmillan Company, 60 Fifth Avenue, New York, N. Y., $8.50.

An Introduction to the Thermal Processing of Foods, 1961, S. A. Goldblith, M. A. Joslyn, and J. T. R. Nickerson. Avi Publ. Co., Westport, Conn., U. S. $16.50, foreign $17.50.

Les Opérations Unitaires du Génie Chimique, 1961, M. Loncin, Dunod, 92, Rue Bonaparte, Paris, France, 115 NF.

BULLETINS

How Americans Use Their Dairy Foods, 1961, National Dairy Council, 111 N. Canal Street, Chicago 6, Illinois, $1.00.

Vitamin B_{12}, Microbiological Assay Methods and Distribution in Selected Foods, Home Economics Research Report No. 13, June 1961, Harold Lichtenstein, Aram Beloian, and Elizabeth W. Murphy. Human Nutrition Research Division, Agricultural Research Service, U. S. Dept. of Agr., Washington, D. C., free.

Proceedings of the 2nd Symposium of the International Association of Veterinary Food-Hygienists, 1960, Secretariat of the International Association of Veterinary Food-Hygienists, Sterrenbos 1, Utrecht, The Netherlands, $7.00.

Food Costs—Retail Prices, Farm Prices, Marketing Spreads, 1961, Miscellaneous Publication 856, U. S. Department of Agriculture, Washington 25, D. C.

Improving Methods and Facilities for Cattle Slaughtering Plants in the Southwest, 1961, (MRR 436), U. S. Department of Agriculture, Washington 25, D. C.

1960 Agricultural Statistics, U. S. Department of Agriculture, Washington 25, D. C.

Food Technology in Australia, Vol. 13, No. 7, 12 O'Connell St., Sydney, N. S. W., Australia, single copies 3/0.

Science and Food: Today and Tomorrow, Proceedings of a Symposium, Dec. 8, 1960, Food Protection Committee, Food and Nutrition Board, Publication 877, National Academy of Sciences—National Research Council, Washington, D. C.

Horsford's The Army Ration of 1864, Library Bulletin, Supplement No. 1, July 1961, Quartermaster Food and Container Institute for the Armed Forces, Chicago 9, Illinois.

1960 Coffee Statistics, Pan-American Coffee Bureau, 120 Wall Street, New York 5, N. Y.

1960 Financial Facts about the Meat Packing Industry, American Meat Institute, Department of Marketing, 59 E. Van Buren, Chicago, Illinois.

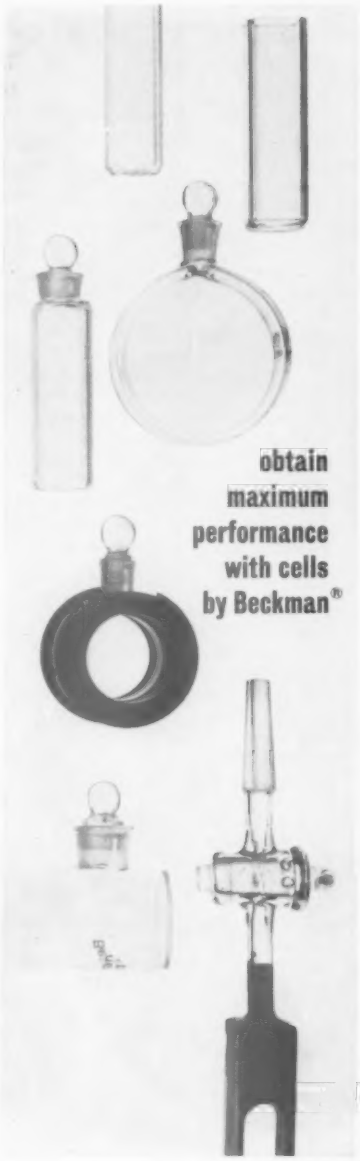
Radioactive Materials in Food and Agriculture, 1961, F.A.O. Atomic Energy Series No. 2.

Loss and Damage in Handling and Transporting Hogs, 1961, (MRR 447), U. S. Department of Agriculture, Washington 25, D. C.

Kernel Slitter and Inspection Belt for Peanuts, 1961, (MRR 452), U. S. Department of Agriculture, Washington 25, D. C.

Effects of High-frequency Electric Fields on Certain Species of Stored-grain Insects, 1961, (MRR 455), U. S. Department of Agriculture, Washington 25, D. C.

Effectiveness of a Special Promotional Campaign for Frozen Concentrated Orange Juice, 1961, (MRR 457), U. S. Department of Agriculture, Washington 25, D. C.



Whether you need:

- silica, Vycor, or Pyrex...
- rectangular, cylindrical, gas, or liquid...
- far UV, UV, visible, or near-IR...
- reflectance, absorption, flow-through, short-path, or demountable...

Beckman's matched cells, with a wide variety of path lengths and with guaranteed transmittance values, bring out the finest possible performance from your spectrophotometers and colorimeters. Also available: Beckman's lime glass test tubes.

Beckman INSTRUMENTS, INC.
SCIENTIFIC AND PROCESS INSTRUMENTS DIVISION
Fullerton, California

Expenditures for Processed Foods by Employee Food Services in Manufacturing Plants, 1961, (MRR 458), U. S. Department of Agriculture, Washington 25, D. C.

Analysis of Selected Varieties and Grades of Rice Moving in World Trade, in Terms of U. S. Official Rice Standards, 1961, (MRR 460), U. S. Department of Agriculture, Washington 25, D. C.

Nature and Fate of Chemicals Applied to Soils, Plants and Animals, 1960, (ARS 20-9), U. S. Department of Agriculture, Washington 25, D. C.

List of Chemical Compounds Approved for use under U.S.D.A. Poultry and Poultry Products Inspection and Grading Programs, 1961, (AMS 419), U. S. Department of Agriculture, Washington 25, D. C.

Report No. 6 of Progress on Investigations of Confectionery Fats, 1961, Southern Regional Laboratory, U. S. Department of Agriculture, New Orleans, Louisiana.

Report of the Technical Meeting on Nutrition in Food Policy and Planning in Asia and the Far East, FAO Nutrition Meetings Report Series No. 28, Columbia University Press, International Documents Service, 2960 Broadway, New York 27, N. Y.

Hodag Silicone Antifoams, Hodag Chemical Corporation, 7247 North Central Park Avenue, Skokie, Illinois.

How to Get the Most Out of Steam Cleaning with Oakite Specialized Detergents, Oakite Products, Inc., 157 Rector Street, New York 6, New York.

Koppers Alkylated Phenols, Tar Products Division, Koppers Company Inc., Koppers Building, Pittsburgh 19, Pennsylvania.

Torbal B.T.L. Chromatographic Desalter, The Torsion Balance Company, Clifton, New Jersey.

The 46th annual publication of "The Almanac of the Canning, Freezing, Preserving Industries" is now available at $5.00 per copy from E. E. Judge, c/o The Almanac, 9 Court Street, Westminster, Maryland.

The 1961 edition of the "Blue Book of **Automatic Merchandising,**" which features 214 pages of illustrated information about the automatic food, merchandise and service vending business, is now available. Listed in the "Blue Book" are vending-machine manufacturing companies, vendable-product suppliers, manufacturers of component parts and services, and operating company members of NAMA. Each listing includes information about the types of products manufactured or supplied and gives the names of company executives. In addition, each listing is indexed according to product. Cost of the book is $3.00 per single copy and $1.50 for each additional copy. Orders should be directed to NAMA, 7 South Dearborn Street, Chicago 3, Illinois.

Hundreds of industrial foaming problems are economically solved with the application of minute quantities of silicone **antifoam agents,** reports Hodag Chemical Corporation in a new product brochure. The eight-page illustrated booklet details the suitability in food processing and packaging of antifoams sanctioned by the Food and Drug Administration, and lists prescribed levels for their use. The new brochure may be obtained by writing to Hodag Chemical Corporation, 7247 N. Central Park Avenue, Skokie, Illinois.

To meet laboratory **freeze-drying** requirements, the American Instrument Company offers three units: a universal model incorporating a mechanical refrigeration unit in addition to a dry-ice and alcohol condenser; a laboratory model designed to take up limited space yet provide maximum working space; and a bench model designed for compact size and ease of portability. Bulletin 2345 completely describes the full line of freeze-drying apparatus offered, and is available without charge from American Instrument Company, Inc., 8030 George Avenue, Silver Spring, Maryland.

Desalting solutions for chromatographic analysis in 5 to 10 minutes are described in a new bulletin on the Torbal B.T.L. Chromatographic Desalter, published by The Torsion Balance Company. The laboratory unit employs ion-exchange membranes, transformer, half-wave rectifier, and potentiometer to reduce salt concentration without raising the temperature of the solution. No mercury is used, and the ion-exchange membranes have a life of not less than one year of continuous use. Copies of the bulletin may be obtained by writing The Torsion Balance Company, Clifton, New Jersey.

A new technical service bulletin entitled "Modern Sanitation for Fisheries" has just been published by Oakite Products, Inc. Topics in the bulletin are: detergents for mechanized cleaning; application techniques; manual and soak-tank cleaning; washing cans after filling; shipboard cleaning; and cleaning racks, conveyors, etc. Also in the bulletin are pictures and technical descriptions, including the use value of three specialized pieces of mechanized cleaning equipment. Further information is available from Oakite Products, Inc., 157 Rector Street, New York 6, New York.

A new bulletin describing Koppers **alkylated phenols** is now available from Koppers Company, Inc. General physical and chemical properties, structural formulas, and major uses and applications are given for four alkylated phenols: para-tertiary-butylphenol (PTBP); para-tertiary-amylphenol (PTAP); 2,4-di-tertiary-amylphenol; and 2,4-di-tertiary-butylphenol. Infrared absorption spectra are reproduced for both PTBP and PTAP. In addition a typical resin reaction is described, from the mixing of reactants to the end product. Copies of the new bulletin, T-205, may be obtained by writing Tar Products Division, Koppers Company, Inc., Koppers Building, Pittsburgh 19, Pennsylvania.

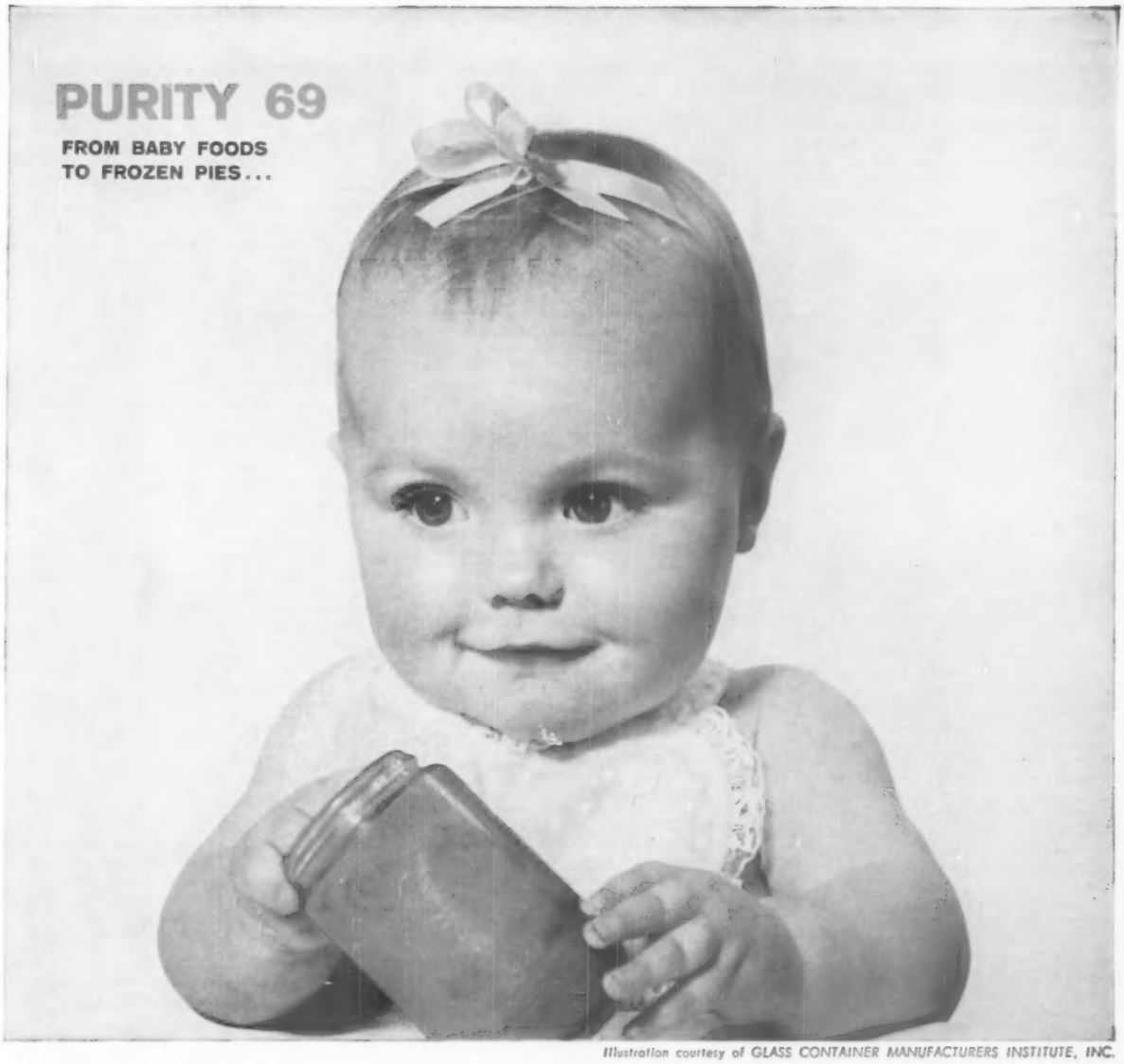


Illustration courtesy of GLASS CONTAINER MANUFACTURERS INSTITUTE, INC.

"FRESH FOOD LOOK" after months of storage

PURITY 69 prolongs storage and shelf life far beyond normal requirements! Stabilizes fruit fillings over a year at refrigerator temperatures while other specialties break down after a week or two. Withstands as many as 40 freeze-thaw cycles while other specialties weep and cause texture changes after two to five "freeze-thaws".

PURITY 69 also offers superb gourmet qualities in taste, texture and clarity. A simple taste-color comparison shows the difference.

PURITY 69 should be evaluated wherever smooth heavy-bodied texture, lack of cereal taste and exceptional shelf-life are desired. Suggested for all types of frozen specialties, canned and jarred foods, canned pie fillings, fruit desserts. Write for information.

National STARCHES

NATIONAL STARCH and CHEMICAL CORPORATION

750 Third Avenue, New York 17 · 3641 So. Washtenaw Avenue, Chicago 32 · 735 Battery Street, San Francisco 11

And All Principal Cities in the United States, Canada and Mexico

SITUATIONS WANTED

Reply directly to ad BY BOX NUMBER (where indicated) via: Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois.

AVAILABLE: Operations Manager, Food Technologist, 40, B.S., MBA. 13 yrs. proven exp. in line management, creative product development, Research and Quality Control. Ability to run an entire food processing operation, direct new product development, institute cost reduction studies and get results, and coordinate consultative services for industrial, merchandising, and procurement staffs. Presently employed as Operations Manager for plant of 50 people. Excellent references. Salary $14,500. REPLY BOX 894.

Management technical advisor. Academic, industrial, and consulting experience in bacteriology, biochemistry, and food technology problems and new product development. Salary area $15,000. REPLY BOX 913.

B.S. degree in Chemistry and Mathematics. 8 yrs. exp. in Statistical Quality Control and as Governmental Food Control Chemist. Some experience with meat. Able to handle correspondence and personnel. Desire position in production, technical service or quality control in South or Southwest. Salary $7,000. REPLY BOX 857.

Responsible growth position desired. Well qualified for technical sales, market development, sales service, or product development. Excellent record of accomplishment in above fields. Major experience in frozen desserts, flavors, and syrups. Prefer west coast. Will consider other locations. BOX 910.

Senior Technologist, Ph.D., age 41, heavy experience in many phases of industrial research. Seeking challenging position in research, production or quality control. REPLY BOX 908.

Swiss, 26, college graduated, seeks post as trainee or assistant superintendent in modern canning plant. Wide practice in vegetable, fruit, pickle and preserves processing. Has good knowledge in pilot plant operation. Could arrange exchange to Switzerland. BOX 911.

PRODUCT DEVELOPMENT position wanted by food technologist. 1950 B.S. degree from University of California. Extensive experience in all phases of product development. Seven years with major food company in U.S.A. Recently one year in Europe with well-known diversified processing and exporting firm. Prefer to work in or near New York Metropolitan Area. Salary, $8,500. BOX 912.

Production or manufacturing management position desired by individual with heavy experience in product development, quality control, production, engineering, and technical service. His degree in chemistry and engineering is supplemented by advanced work in business administration, work simplification, and statistical quality control. Salary, $18,000. REPLY BOX A-1102.

June, 1961 graduate in zoology and chemistry desires position as food technician. Her experience has been in academic research and she has no product preference. Salary, $3,800. REPLY BOX A-0102.

Individual well experienced in fruits and vegetables desires management position, or position involving procurement or sales. Q.C. and fruits and vegetable production experience combined with degree in business administration. REPLY BOX A-0110.

Individual experienced in quality control and product development desires position as Buyer. Product experience includes meats, fruits and vegetables, and poultry and eggs. Salary, $7,500. REPLY BOX A-0113.

Recent graduate desires position in quality control, microanalysis, or product development within the food industry. Limited experience with many food products in these areas. Salary, $6,200. REPLY BOX A-0116.

Dairy products interest individual with production, product development, and quality control experience in this area. Position desired is production supervisor or similar. Salary, $6,500. REPLY BOX A-1103.

Young man desires position as technical service representative or product development technologist. His experience includes meats, fruits, vegetables, poultry and eggs, fats and oils, citrus, and nut meats. Salary, $7,200. REPLY BOX A-1106.

June, 1961 food technology graduate with vending machine experience desires product development, packaging, or industry research position. Salary, $6,500. REPLY BOX A-1108.

Sales management position desired by individual with over 11 years experience in technical sales, plus experience in production, engineering, and research. Salary, $18,000. REPLY BOX A-1109.

Technological position in product development desired by 1961 M.S. in food technology. Experience and product preference both include meat and vegetable products. Salary, $6,500. REPLY BOX A-1112.

Food technology graduate with experience in cereals and baked goods, spices, macaroni, and meats, desires technical service, sales, or industrial research position. Salary, $9,000. REPLY BOX A-1113.

Production, quality control and packaging, in that order, interest 1961 food technology graduate who has summer experience in fruits and vegetables. REPLY BOX A-1118.

Position as quality control manager or product development supervisor desired by food technologist with experience in these areas. Has worked with meats, and cereals and baked goods. REPLY BOX A-1119.

Sales or research position desired by recent graduate with experience in technical service, quality control and technical sales. Prefers to work with canned foods, jams or jellies. Salary, $6,000. REPLY BOX A-1120.

Food Technologist desires position as such, in the areas of product development, packaging, or quality control. Has worked with fruits and vegetables, and sugars and syrups in production and quality control. Salary, $6,000. REPLY BOX A-1133.

Eleven years experience in administrative and executive capacity while working in product development and technical service in the area of prepared foods are qualifications set forth by individual who desires position as laboratory manager in applied food research. Salary, $13,000. REPLY BOX A-2126.

Meats and dehydrated foods interest chemist with quality control and product development experience. Has also had experience in chemical and instrumental analysis of food. Salary, $9,000. REPLY BOX A-2127.

Thirteen years experience in product development is qualification set forth by individual interested in dehydration and gel systems. He holds degree in chemistry and has worked with pectic substances and emulsion technology. Salary, $9,000. REPLY A-2128.

Position in quality control or production desired by chemist who is interested in working with fruits or vegetables. Salary, $9,500. REPLY BOX A-2130.

Situations Wanted—
Supervisory position in new product development and/or technical sales-service desired by individual holding title of Manager, New Product Development. He is thoroughly experienced in these areas. Salary, $11,500. REPLY BOX A-2131.

Sales or research position working with metal closures and glass containers desired by chemical engineer. Has had eighteen years experience in technical service. Salary, $12,000. REPLY BOX A-3104.

Individual with heavy experience in product development plus management and planning experience desires research, production, technical service, management or liaison position. Salary, $13,500. REPLY BOX A-3105.

Chemical and industrial engineering graduate with many years engineering and research experience desires product and process development position. He has worked with many types of foods, as well as vitamins and adhesives; he prefers a west coast location. REPLY BOX A-3401.

Bacteriologist desires technical service, product development or production position. He has had five years quality control experience with frozen foods, preserves and peanut butter. Salary, $7,500. REPLY BOX A-4103.

Frozen desserts interest individual who seeks position in technical sales, sales development or sales service. He has also had experience in production and product development. Salary, $13,000. REPLY BOX A-5101.

Line or staff position in manufacturing, packaging or engineering desired by experienced factory management graduate. Salary, $10,000. REPLY BOX A-9104.

POSITIONS AVAILABLE

Reply directly to ads BY BOX NUMBER (where indicated), including the company name of your current employer, via: Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois.

CHEMIST or FOOD TECHNOLOGIST: For Quality Control in Cookie Manufacturing. Two years minimum experience. Must be agreeable to relocate, Chicago or New York area. Salary to $6000. Submit résumé, references and college transcript. BOX 907.

PRODUCT DEVELOPMENT
QUALITY CONTROL

A small and rapidly expanding middlewest processor of fruit juices and fruit juice drinks has an opening for a young college-trained Food Chemist or Chem Engineer. Responsibilities will be to conduct experiments and investigations to improve product line and processing efficiencies. Applicant must have at least three years' experience in related fields.

Salary will depend upon qualifications and experience. Please include details of education and experience in initial reply. REPLY BOX 904.

FOOD TECHNOLOGISTS

Opportunity in **Process Development Engineering** Department of midwestern manufacturer.

Will develop commercial scale processes of new products and identify and correct processing problems of present production.

Requires B.S. degree in food technology or food engineering, and interest or experience in **candy and/or bakery** products.

Liberal benefits, including profit sharing bonus, and moving allowances. Replies Confidential.

BOX 909

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

RESEARCH MYCOLOGIST

Large internationally known food processing company with general offices in the East has need for Research Mycologist with knowledge of yeast and mold taxonomy with grounding in biochemistry and microbial physiology. Interest in the enzymes of yeasts and molds desirable. Permanent industrial position with growth potential. Write—

S–36, P.O. BOX 2066
Philadelphia 3, Pa.
(An Equal Opportunity Employer)

SEAFOOD PRODUCT DEVELOPMENT

Opportunity of broad scope in Product Development and Research of dehydrated foods emphasizing fishery products. Large expanding company with excellent benefits. New research facility in desirable suburban Chicago location. Send résumé to BOX 906.

Food technologist. Eastern location. B.S. degree and no experience required, to conduct research investigations for product development. REPLY BOX X-0205.

Jr. technologist. Eastern location. Bachelor's degree and no experience required for performing laboratory experiments and instructing others in routine lab work. REPLY X-0206.

Assistant technologist. Eastern location. B.S. and 2–3 years experience, to conduct advanced laboratory experiments on pilot plant development. REPLY BOX X-0207

East coast location. B.S. or equivalent plus five years of project and development work including supervisory required for R & D projects and future laboratory supervision. REPLY BOX X-0209.

Food technologist. Midwest location. Degree required for product development, quality control and production supervision. REPLY BOX X-0301.

Positions Available—
Food Research Specialist. Eastern location. B.S. or above in food technology or chemistry required, plus three years research experience. Salary, to $10,500. REPLY BOX X-1207.

Plant Superintendent. South America. Experience in cannery production plus laboratory knowledge and quality control required of individual with food technology or chemistry degree. Position entails production and packaging. REPLY BOX X-1104.

Food Technologist. Eastern location. One to three years experience in food research and B.S. in food technology or closely related field required. Major qualification is good engineering or mechanical ability and familiarity with the unit operations involved in food processing. Salary, $7,200. REPLY BOX X-1203.

Food Technologist. Eastern location. Degree in food technology or related science and 2 to 3 years experience in research required of individual who will provide expert and up-to-date knowledge on all aspects of freeze-dehydration of foods. Salary, $7,200. REPLY BOX X-1204.

Food Technologist. Eastern location. M.S. or B.S. with minimum of three years industrial research experience involving the application of scientific knowledge in developing new or improved products and processes. REPLY BOX X-1205.

Food technologist. Eastern location. B.S. in food technology or chemistry with 0–2 years experience in meat, cereal and baking, or canning, to develop applications of products to the food industry. REPLY BOX X-1208.

Quality Control Manager Trainee. Eastern location. Minimum educational requirement is B.A. or B.S. in food technology, with experience in bacteriology, dairy, egg and bakery products desirable. Position will lead to supervisory capacity. REPLY BOX X-1209.

Food Technologist. Midwest location. Experience in development work with fresh and processed meats desirable; B.S. in food technology required. Duties will include development of product and process of fresh meat items and/or processed meat development and research. Salary, $6,400. REPLY BOX X-1308.

Food Technologist. Midwest location. Experience desirable and food technology or related degree required, for quality control, product development, and bacteriological work on fruits and vegetables. Salary: $7,000. REPLY BOX X-1309.

Junior Chemist. Midwest location. Recent food technology or chemistry graduate required for non-routine work in control laboratory. Ability and interest to progress to a responsible administrative position. REPLY BOX X-1315.

Food Technologist. Midwest location. Recent food technology or chemical engineering graduate desired for developmental work, improved formulation and general research. Salary, $5,600. REPLY BOX X-1316.

Production trainee. Western location. B.S. or B.A. in food technology or related fields required for above position in fruit and vegetable canning operations. REPLY BOX X-1402.

Food Technologist. Southern location. Recent food technology or chemistry graduate desired to work under direction of quality control manager. Responsible for laboratory aides, maintenance of product standards, bacteriological controls and acceptability of containers. Salary, $6,100. REPLY BOX X-1501.

Eastern location. Five years industrial experience in specialty foods plus B.S. in chemistry or chemical engineering required. Will work closely with and in production, and be involved in product development and supervision of control laboratory. Salary, $8,000. REPLY BOX X-2201.

Flavor Chemist. East coast location. Four years experience and B.S. in chemistry or equivalent, to create and improve flavor compounds in the essential oil field. REPLY BOX X-2207.

Food Technologist. Eastern location. B.S. in chemistry or food technology and up to five years experience required of individual who will be involved in field service and development work on basic food components used by canned, frozen, baked and confectionery manufacturers. Salary, $7,500. REPLY BOX X-2210.

PROFESSIONAL DIRECTORY

COMPLETE SERVICE . . . for the FOOD INDUSTRY!
Radioactive, Infrared Spectroscopy, Food Additive Studies, Bacteriology. Write for Price List.
SCIENTIFIC ASSOCIATES
3755 Forest Park Avenue
St. Louis 8, Mo. JE. 1-5922

WISCONSIN ALUMNI RESEARCH FOUNDATION
LABORATORY SERVICES
Applied Research and Development, Testing and Consultation • Food, Feed, Drug and Chemical Analyses, Animal Studies, Pesticide Screening, Pesticide and Additive Residue Analyses
For price schedule and specific work proposals, write
WARF
P. O. Box 2217 • Madison 5, Wisconsin

Consultation and Research since 1922
Food and Drug Research Laboratories INCORPORATED
Toxicology
Pharmacology
Nutrition
Biochemistry
Bacteriology
BERNARD L. OSER PH.D.
Director
Maurice Avenue
at 58th St., Maspeth 78
New York City
TWining 4-0800
WHERE EXPERIENCE COUNTS

Schwarz
PROFESSIONAL SERVICES
Since 1869 Schwarz Laboratories has been a leading laboratory and technical service for the food and beverage industries.
We offer thorough, expert advice on food problems of all types, analyses, flavor evaluations, product development, and legal testimony. Costs are low due to our experience and efficient operation and equipment.
May we send you our brochure?
SCHWARZ LABORATORIES INC.
230 Washington St.. Mount Vernon, N.Y.
Phone: MO 4-1100 Cable: Swoknip

Advertisers' Index

Air Reduction Sales Company 31
•Allied Chemical Corporation
American Can Company 4
•American Food Laboratories
•American Sterilizer Company
•American Viscose Corporation
•Archer-Daniels-Midland Company
•Archibald & Kendall, Inc.
•Aseptic Thermo Indicator Company
•Bausch & Lomb Optical Company
Beckman Instruments, Inc. 39
•Blumenthal Bros. Chocolate Company
*Clinton Corn Processing Co. 448A
Continental Can Company 13
Corn Products Sales Company 11
•Dairyland Food Laboratories, Inc.
*Diamond Crystal Salt Company 420A
Distillation Products Industries 8, 9, 416B
*Dodge & Olcott, Inc. 428A
Dorr-Oliver Incorporated 25
•The Dow Chemical Company
•Dragoco Inc.
•Drake Personnel, Inc.
Paul A. Dunkel and Co. Inc. 19
•Durkee Famous Foods
Eastman Chemical Products, Inc. 29
•Evans Research
Felton Chemical Company, Inc. 37
Firmenich, Inc. 1
Flavorex Co., Inc. 28
*Florasynth Laboratories, Inc. 452A
Food and Drug Research Laboratories, Inc. 44
•Food Machinery & Chemical Corporation
*Food Materials Corporation 420B
The Foxboro Company 34, 35
Fries & Fries, Inc. 6
Fritzsche Brothers, Inc. 26
•Girdler Process Equipment Division
*Givaudan Flavors, Inc. 444A
*The Griffith Laboratories, Inc. 412B
Hercules Power Company, Inc 24
*Hoffmann-LaRoche Inc. 448A
•The Hubinger Company
•Chas. L. Huisking & Co., Inc. (Glyco)
•Information for Industry, Incl.
International Flavors & Fragrances Inc. ..... 2nd Cover
Kel Instruments Company 17
*Kelco Company 428B
•Klenzade Products, Inc.
•Knickerbocker Mills Co.
•H. Kohnstamm & Co., Inc.
•Kraft Foods
•Macbeth Daylighting Corp.
Magnus, Mabee & Reynard, Inc. 12
Manton-Gaulin Manufacturing Co., Inc. 2
•Meer Corporation
*Merck & Co., Inc. 452B
*Miles Chemical Company 416A
*Morningstar-Paisley, Inc. 432D
*Morton Salt Company 436A
•The National Drying Machinery Company
National Starch & Chemical Corporation 41
The Nestlé Company, Inc. 15
Norda Essential Oil & Chemical Company, Inc. ..... 4th Cover
Henry H. Ottens Mfg. Co. 16
•Patterson-Kelley Co., Inc.
•Penick & Ford, Ltd., Inc.
•S. B. Penick & Company
*Chas. Pfizer & Co., Inc. 432B, 432C
Photovolt Corporation 19
•PFW
Proctor & Schwartz, Inc. 17
•RCA Industrial Electronics Products
•Refined Syrups & Sugars, Inc.
•Reinhold Publishing Corp.
•RePP Industries, Inc.
•Research, Inc.
•Reitz Manufacturing Co.
F. Ritter & Company 23
*Rohm & Haas Company 412A
•C. G. Sargent's Sons Corporation
Schwarz Laboratories, Inc. 44
Scientific Associates 44
•Speas Company
•Wm. J. Stange Company
*Sterwin Chemicals, Inc. 432A
•Sugar Information, Inc.
•Swift & Company
•Truesdail Laboratories, Inc.
•S. Twitchell Company
Ungerer & Company, Inc. 18
•Union Carbide Chemicals Company
•U. S. Stoneware Company
•United States Testing Co.
*Urschel Laboratories Inc. 444B
•Vanilla Laboratories, Inc.
*Verona Aromatics 436B
•Virginia Dare Extract Co., Inc.
•Warner-Jenkinson Manufacturing Company
•R. D. Webb & Co., Inc.
Western Condensing Company ..... 3rd cover
•John Wiley & Sons, Inc.
Wisconsin Alumni Research Foundation 44

* Advertisements appearing in technical section.
• Advertisers appearing in previous 1961 issues.

Profitable new uses for Lactose are still being discovered. Are you sharing in the benefits of this versatile product?

Many progressive food processors use Lactose to enhance flavors and aromas, control sweetness levels, aid proper browning and carmelization, and as a free-flowing anti-caking aid. It is used in preserves, spices, barbecue sauce, salad dressing, cottage cheese, candies, baked products, party dips, frozen vegetables, pie fillings, fruit drinks...to name a few. It is now available in a variety of colors, also in pure white.

Many other food products could benefit from Lactose. Could yours? For full information, just send the coupon to Western Condensing, world's largest producer of Lactose.

ONLY WESTERN CONDENSING PRODUCES EDIBLE LACTOSE IN THE FULL RANGE OF GRANULATIONS REQUIRED BY THE FOOD FIELD!

Now! Fact-filled folder about Lactose and its valuable applications in the food field. Send for yours today!

Please send me free Lactose Technical Bulletin L-1.

Name_____

Title_____

Company_____

Address_____

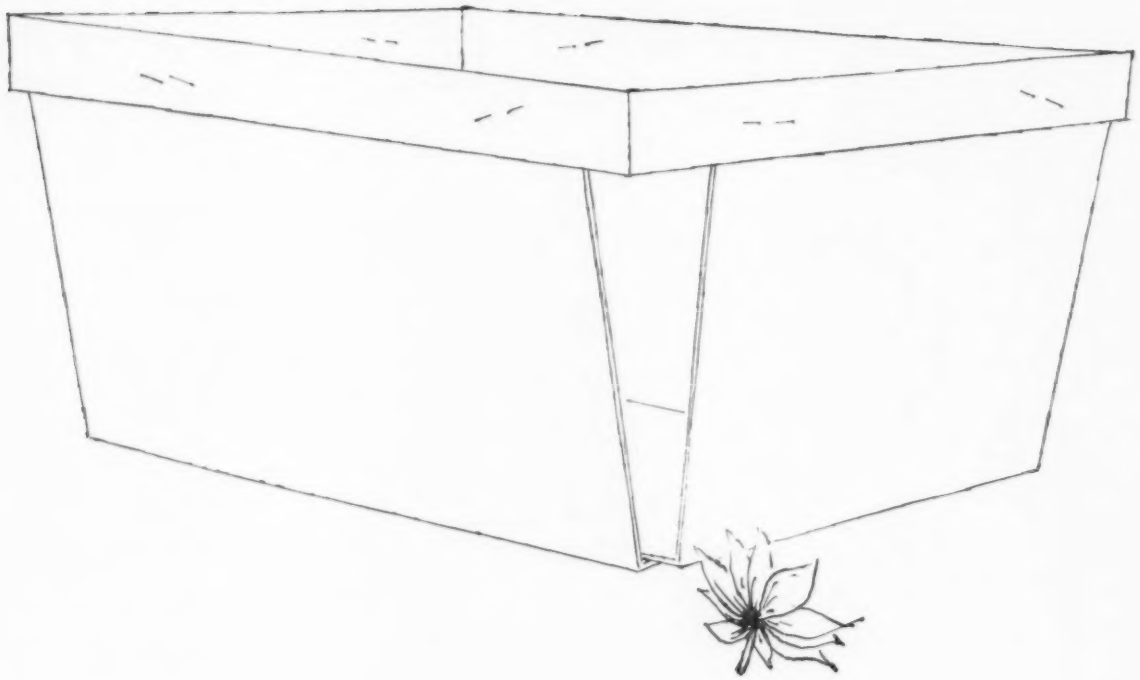
City_____ Zone____ State_____

19J

FOREMOST DAIRIES, INC.
WESTERN CONDENSING COMPANY DIVISION
Appleton Wisconsin

Foremost®

lactose

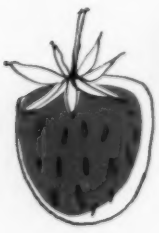


When all is said and done...

...NOTHING

TASTES SO TRUE

TO NATURE



Norda®

Flavor it with a favorite

Exclusive Basic Materials for: Candy and Chewing Gum, Dairy Products (Ice Cream and Cheese), Soft Drinks, Desserts (Puddings and Gelatins), Meat Products, Syrups, Bakery Products (Cake Mixes, Crackers, Snack Items), Pharmaceutical Products, Liquors and Cordials.

Write on your letterhead for free samples.

NORDA, 601 W. 26 St., New York 1, N.Y. • Chicago • Los Angeles • San Francisco • Toronto • Montreal • Havana • London • Paris • Grasse • Mexico City